Alaska Department of Environmental Conservation

DIVISION OF WATER PROGRAMS

Environmental Analysis Section

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AN ENVIRONMENTAL ASSESSMENT OF LOWER COOK INLET FOR OUTER CONTINENTAL SHELF AND RELATED DEVELOPMENT

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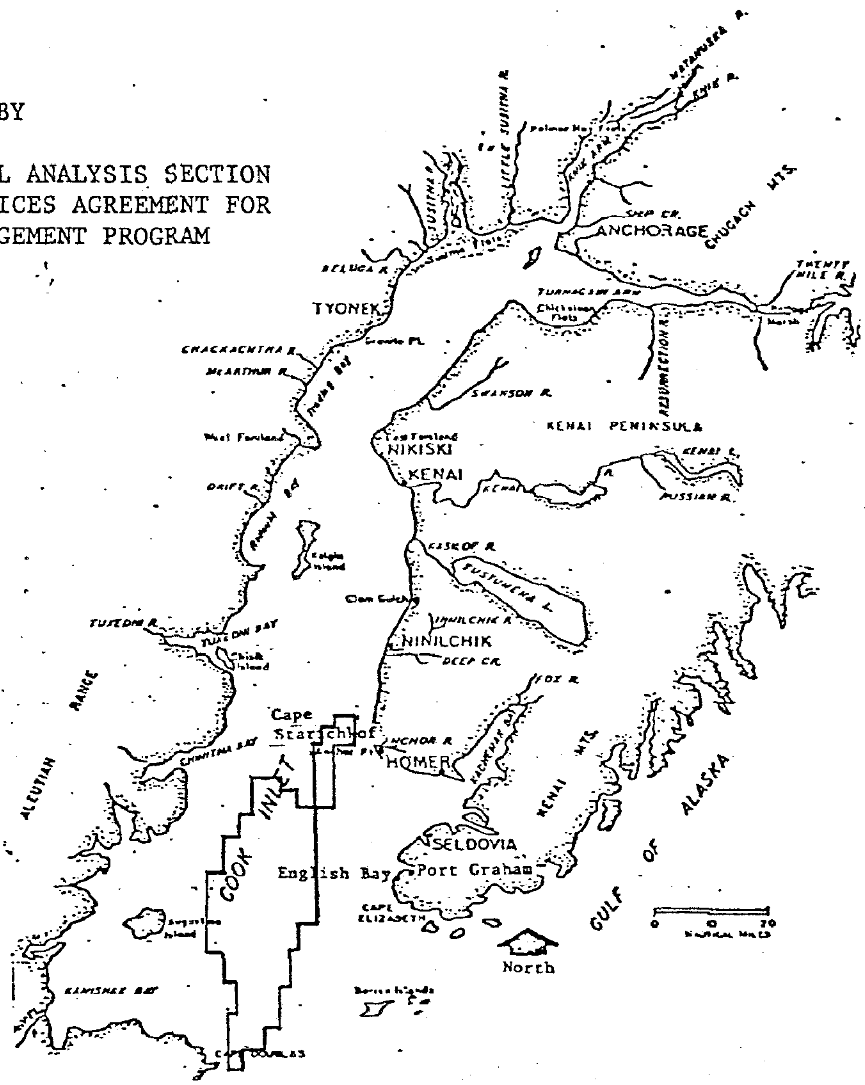

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1976

AN ENVIRONMENTAL ASSESSMENT OF LOWER COOK INLET

The Cook Inlet region of Alaska has been the site of substantial industrial development since the late 1950's, catalyzed by the first oil discoveries by Atlantic Richfield at Swanson River. With the subsequent discovery of the Middle Ground Shoal field in upper Cook Inlet in 1962, offshore drilling and oil production came of age in Alaska. The land-based infrastructure required to support offshore operations and the development of improved technology to accommodate drilling in marine waters presented unique problems to both industry and the community. Increased demand for municipal and utility services, cost of living increases, economic dislocation and habitat encroachment are but a few of the realities to be confronted during the boom economy generated by oil and gas development.

Oil and gas development in the lower Cook Inlet region will soon be following a course similar to that established in the northern inlet. Federal lands on the Outer Continental Shelf (OCS) in lower Cook Inlet are scheduled to be leased by the Bureau of Land Management in February or March, 1977. In order to properly direct this development to achieve a minimum of environmental, social, and economic disruption, the planning process must begin as early as possible. This effort must be interdisciplinary in nature, drawing on the combined expertise of social planners, economists and environmental scientists from several levels of government in formulating a developmental policy. Many of the questions surrounding development in lower Cook Inlet have precedent in upper Cook Inlet which facilitates finding solutions. Others are unique to lower Cook Inlet.

There is a pressing need for a comprehensive evaluation of alternative development options for lower Cook Inlet and of the infrastructure and environment of coastal areas most likely to be confronted with industrial buildup. A necessary precursor to this evaluation is an inventory of environmental, social, and economic values at the alternative coastal sites.

This report, An Environmental Assessment of Lower Cook Inlet, attempts to fulfill one of these data requirements. The report provides both a regional overview and a site-specific analysis of environmental conditions and present human uses of lower Cook Inlet. Coverage includes coastal communities potentially impacted and extends to remote unpopulated areas that are candidates for onshore facility sites and support infrastructure. The primary basis for the onshore facility site selections was industry interest, as indicated through proposed alternative sites in the DEIS for lower Cook Inlet (U.S. Dept. Interior, 1976). Other sites that appeared feasible from a physical standpoint were also included. The report is divided into two sections:

(1) a regional environmental overview of lower Cook Inlet;

(2a) environmental analysis of potential development locations (communities and nonpopulated areas);

(2b) a review of existing infrastructure and human uses at these sites.

Environmental considerations include coastal hazards and other natural constraints, tidal wetlands, lower trophic level marine resources, and fish and wildlife resources. Documented human use patterns include the recreational and heritage resources, fishing, hunting, shipping and communication networks.

The purpose of this review is to provide information for use in identifying the relative environmental sensitivities of various proposed development sites and for reviewing and formulating recommendations on permit applications and other proposals pertaining to coastal development activities. This resource information, when integrated with social and economic analyses, should help to resolve such issues as determination of permissible uses, and contribute to establishing state policy for water and land use management in these areas. This information will serve as a basis for systematic assessment of coastal hazards and plant and animal communities subject to the impacts of human uses in lower Cook Inlet.

The Department of the Interior's Outer Continental Shelf oil and gas leasing program for lower Cook Inlet has provided the impetus for this documentation of the natural resources and processes of the coast. Dredge and fill operations, sewage and solid waste management, transportation of petroleum products and construction of communication networks represent some of the issues which require careful consideration in planning responsive coastal development programs.

TABLE OF CONTENTS

REGIONAL ENVIRONMENTAL OVERVIEW OF LOWER COOK INLET

Physical and biological conditions vary considerably within lower Cook Inlet. A discussion of regional processes, productivity, and infrastructure is included in this section as a prelude to providing a more site-specific perspective in subsequent sections.

Environmental factors considered in this regional overview include:

(1) Coastal hazards and natural constraints: sea ice, seismic risk, erosion and deposition, flooding, tsunamis, wind, volcanism, waves, and tidal currents.

(2) Marine primary producers and consumers: plankton, macrophytes, intertidal invertebrates, and benthos.

(3) Tidal and contiguous freshwater wetlands.

(4) Fish and wildlife resources: finfish and shellfish, terrestrial and marine mammals, seabirds and coastal waterfowl.

(5) Infrastructure, economic base and human uses: industry, facilities, and present impacts.

Coastal Hazards and Natural Constraints

Coastal environmental hazards and other natural physical constraints common to lower Cook Inlet include sea ice, seismic risk, erosion and deposition, flooding and catastrophic waves, volcanism, wind, waves and tidal currents. Environmental hazards increase development costs and increase the frequency and magnitude of pollution incidents. Through recognition of hazards in advance, it is possible to avoid or minimize most adverse by properly siting facilities. Failure to acknowledge natural hazards and constraints can result in unnecessary property damage, pollution, and economic hardship.

During severe winters, seasonal sea ice thick enough to be a danger to shore facilities and shipping is found along lower Cook Inlet as far south as Cape Douglas on the western side of the inlet and Anchor Point on the eastern side (U.S. Dept. Commerce, 1964). Floe ice carried southward through the Forelands into lower Cook Inlet is a hazard to navigation approximately 4 months each year. During the winter, interaction between tidal currents and ice creates severe problems which are unique to Cook Inlet, occasionally creating hazardous docking conditions and tanker loading operations (U.S. Army Corps Engineers, 1974a; U.S. Coast Guard, 1976). Tides stack shore ice into large multilayered blocks up to 40 feet thick, called stamukha (Hutcheon, 1972). Stamukha ice is one of the primary causes for numerous ice-related shipping accidents which occur each winter. From January through April 1972, 6% of the 142 ocean-going vessels that operated in the ice-stressed areas of Cook Inlet were damaged by ice (U.S. Army Corps Engineers, 1974a).

AN ENVIRONMENTAL ASSESSMENT OF LOWER COOK INLET FOR OCS AND RELATED DEVELOPMENT AK-A76

ALASKA COASTAL MANAGEMENT PROGRAM AND WATER PROGRAMS/ENVIRONMENTAL ANALYSIS SECTION

Earthquakes also constitute a high risk to lower Cook Inlet communities and shore-based facilities. The entire region lies within a zone of high seismic risk (U.S. Dept. Commerce, 1976c) (Fig. 1). Many earthquakes of magnitudes greater than 6.0 on the Richter scale have occurred in the region since 1899, and more will undoubtedly occur.

The shores of Cook Inlet along the Kenai Peninsula subsided as much as 3.5 feet as a result of the 1964 earthquake; this accelerated erosion along the entire west shore of the Kenai Peninsula (Stanley, 1967). Foster and Karlstrom (1967) report subsidence figures of a foot or less from Anchor Point to Point Possession with little change in undercutting of stabilized vegetated colluvial slopes compared to previous years. However, the Corps of Engineers (1974b) states that coastal areas in the region that were formerly stabilized are now inundated by high tides. The unconsolidated sediments underlying most of the Kenai Peninsula are very susceptible to erosion; Homer, Kenai, and Ninilchik have all expressed need for assistance in dealing with erosion and/or siltation problems (Alaska Dept. Environmental Conservation files).

Erosion contributes materials to littoral transport along Cook Inlet, in many cases creating deposition problems elsewhere. As an example, the construction of two rock jetties at Ninilchik has interfered with normal shore currents, thereby blocking northward movement of littoral sediment. This has caused intensified erosion of the beach to the north of the jetties (U.S. Army Corps Engineers, 1974b).

Although the historical frequency of flooding along most of the lower Cook Inlet coast has been low, this hazard represents a serious concern to coastal communities (U.S. Army Corps Engineers, 1976). Mapping by the Army Corps of Engineers (1973b) of areas subject to 100-year flooding for Homer, Anchor Point, and Ninilchik shows extensive areas vulnerable to flooding.

Past flooding in the lower Cook Inlet region has been associated with ice jamming, coastal inundation from storms and/or abnormally high tides, volcanic eruptions, glacier outburst floods, and tsunamis (U.S. Army Corps Engineers, 1972; 1976). Tsunamis, with associatef flooding and coastal damage, are rare in the inlet, however, tsunami risk does exist. Ten earthquakes with a Richter magnitude of 6.0 or greater have occurred in the Cook Inlet area since 1899. Quakes of this magnitude could produce a significant tsunami in the inlet (U.S. Army Corps Engineers, 1974a).

Flooding may also be generated by massive mudflows or landslides associated with volcanic eruptions. Of the five active volcanoes in the inlet region, only Mount Augustine is capable of a "krakatoan" eruption which could produce tsunamis in Cook Inlet. The 1883 eruption of Mount Augusting produced a huge mudflow, which generated a large wave of 7-10 meters amplitude; this struck English Bay and caused some damage (Selkregg et al., 1974). In addition, the Drift River Valley flooded when Mount Redoubt erupted in 1966. A 15-foot levee has been constructed to protect the Drift River Pipeline Terminal from similar flooding (U.S.Army Corps Engineers, 1974a).

Ash falls from historic volcanic eruptions have blanketed hundreds of square miles in the region (Wilcox, 1959). However, volcanic events affecting lower Cook Inlet are infrequent (U.S. Army Corps Engineers, 1974a). The western shores of Cook Inlet are vulnerable to additional destructive phenomena associated with volcanism, because they are closer to active volcanoes. Phenomena include nuees aredents, lava flows, flash floods, tephra falls, mud flows, explosive blasts, and associated block falls (Kienle, oral and written commun.).

Northerly winds generally prevail over Cook Inlet during winter, while southerly winds predominate from May through September. Strongest winds usually blow either up or down the inlet. Winds of 50-75 knots occur in Cook Inlet nearly every winter (U.S. Dept. Commerce, 1964; U.S. Army Corps Engineers, 1974b). In extreme conditions, winds of 75-100 knots occur over open water (Searby, In: U.S. Dept. Interior, 1976). Strong westerly gales are reported to occur along the west coast of lower Cook Inlet (U.S. Dept. Commerce, 1964). Winds of approximately 25 knots which last for 14-24 hours develop maximum wave conditions along the eastern shore of Cook Inlet. Fully developed deep-water wave height for these winds is 14 feet (U.S. Army Corps Engineers, 1974b).

Circulation in Cook Inlet is predominantly tidal driven. Mass balance is achieved through a net flow of water out the west side of the inlet to compensate the fresh water input to the headwaters. Tidal flood waters enter primarily through Kennedy Entrance; ebbing waters also exit

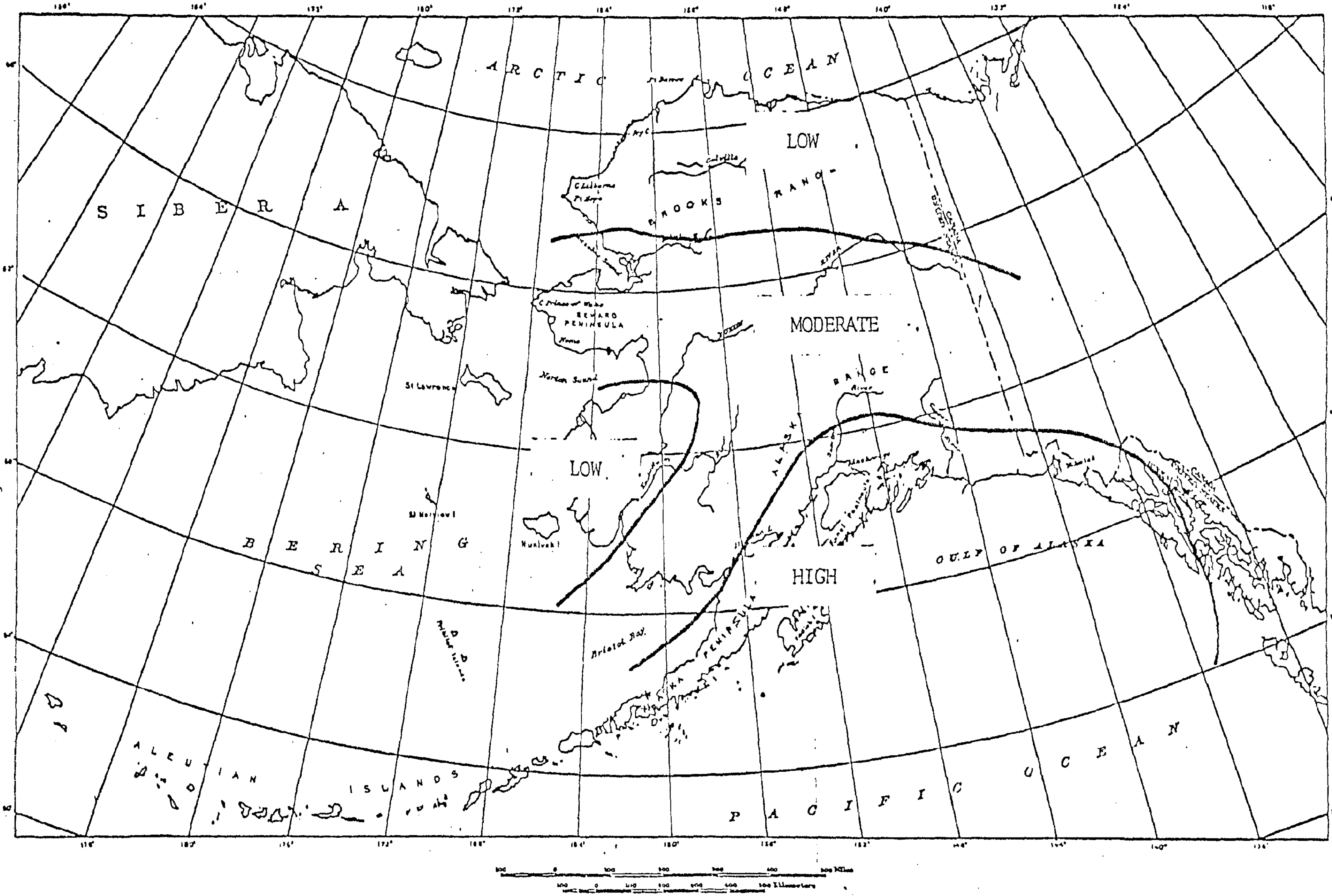
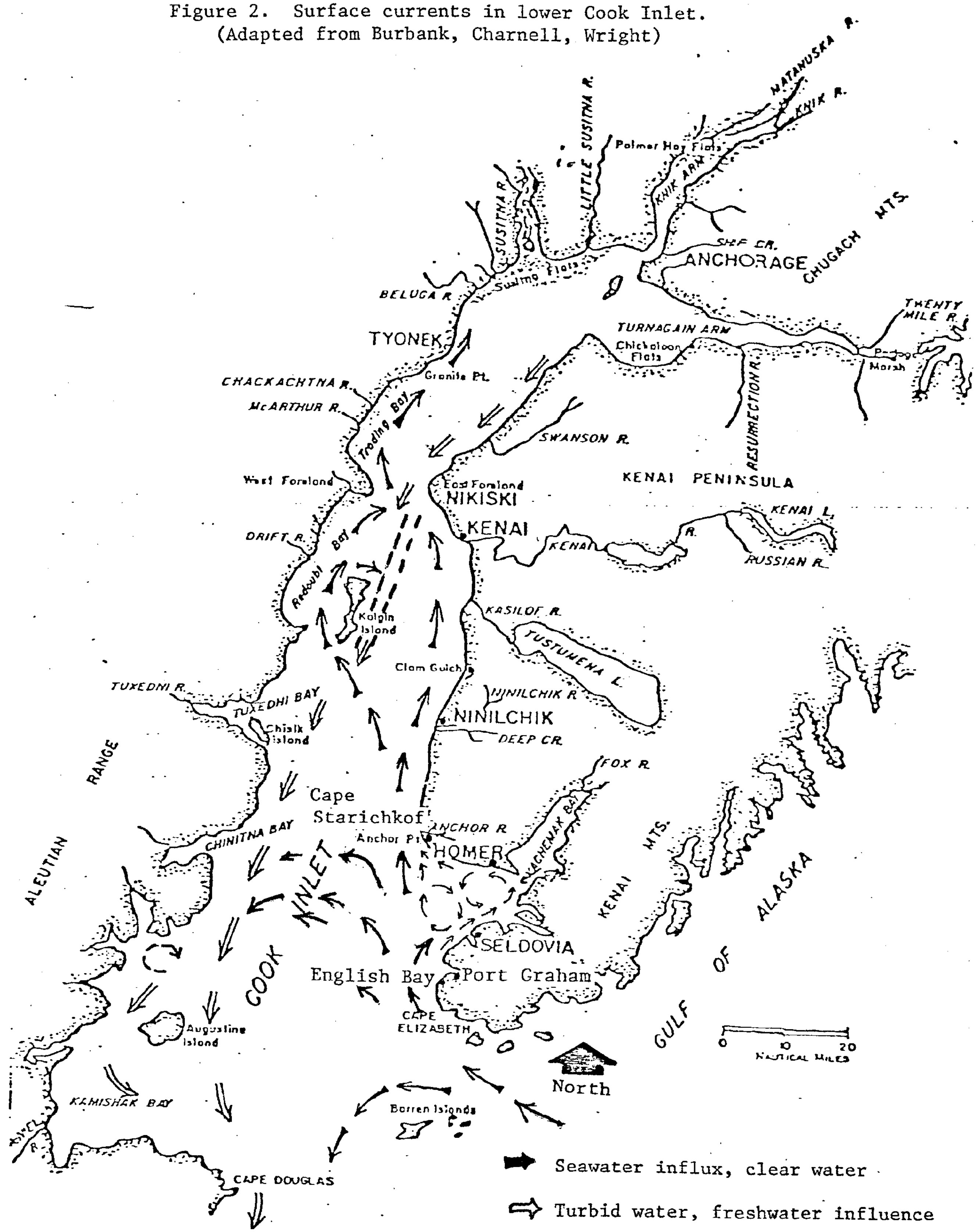


Fig. 1.. SEISMIC RISK ZONES IN ALASKA
(Adapted from U.S. Army Corps of Engineers, 1973) by ADEC, 1976

through this eastern entrance. The water column throughout Cook Inlet is apparently largely homogenous as interpreted from limited temperature and salinity data (Charnell, pers. commun.). Vertical stratification of current flow (countercurrents, etc.) does not appear to occur, rather, the entire mass moves in one direction on both ebb and flooding tides. Current meter data are lacking, particularly for winter months. Wind-driven currents may complicate surface and near-surface circulation patterns. The combination of wind-driven and tidal currents acts to "push" inlet water into Kamishak Bay through the Coriolis effect, especially in winter when northerly winds prevail. Burbank (pers. commun.) has found that a persistent southerly wind at 20 knots sets up a northerly current which enlarges the clockwise gyre at the mouth of Kachemak Bay (Fig. 2). Spring tides also appear to enlarge this gyre. A persistant inner counterclockwise gyre located nearer the Homer Spit has been documented through radar-tracked current drogue data. This inner gyre appears to complete one revolution every 10-14 days.

A persistant mid channel tidal rip ("trash line") occurs east of Kalgin Island and is an area of convergence (downwelling) with the potential for concentrating pollutants (Burbank, pers. commun.). Salmon gillnet fishermen concentrate much of their effort in this region and have reported downward movement of nets.

Figure 2. Surface currents in lower Cook Inlet.
(Adapted from Burbank, Charnell, Wright)

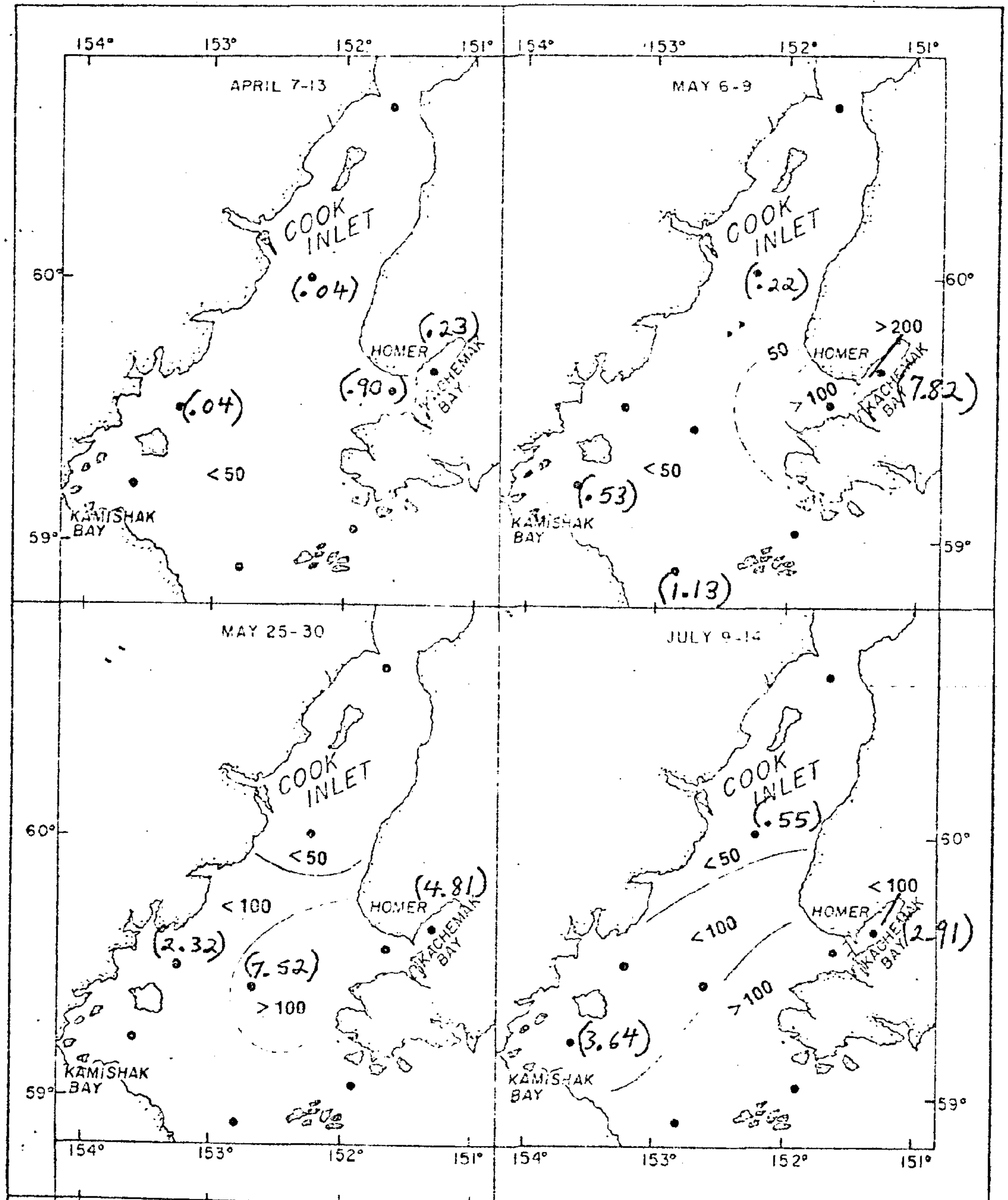


Marine Primary Producers and Consumers

The lower trophic level organisms of Cook Inlet are classified into two groups--producers and consumers. The primary producers are the phytoplankton, macrophytes, and benthic microalgae. The lower level consumers include the zooplankton, ichthyoplankton, and intertidal and subtidal invertebrates. These groups exhibit variable degrees of productivity and diversity depending on the influence of the physical environment and biological interractions.

Phytoplankton diversity and abundance in Cook Inlet are highest in the lower Inlet. The southern influx of cold, saline oceanic water set northerly along the east coast of the inlet promotes rapid mixing and allows sufficiently deep light penetration for relatively high phytoplankton productivity. Water mass transport along the western shore is predominantly southerly, characterized by relatively turbid, lower salinity water (Fig. 2). Primary production in the northern inlet is limited by a high suspended sediment load that reduces light penetration (Murphy et al., 1972).

Primary production is highest in the protected fiords along the outer Kenai Peninsula and in coastal embayments such as Kachemak Bay, with the spring bloom normally occuring during April-May (U.S. Dept. Interior, 1976). Larrance (pers. commun.) measured rates of primary production and standing stock in lower Cook Inlet during spring and summer of 1976 (Figs. 3 and 4). Values were maximal in Kachemak Bay in early May--



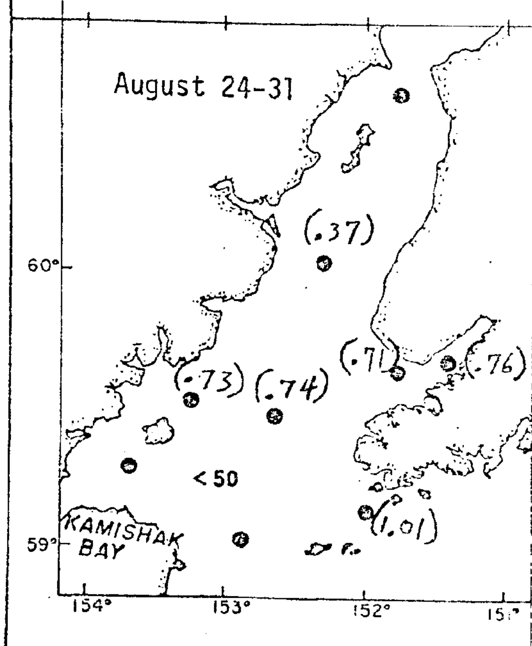


Figure 3

Chlorophyll a in the upper 25 meters (mg Chl-a/m^2) and daily primary production in the euphotic zone (gC assimilated/m^2). Values in parentheses are production numbers.

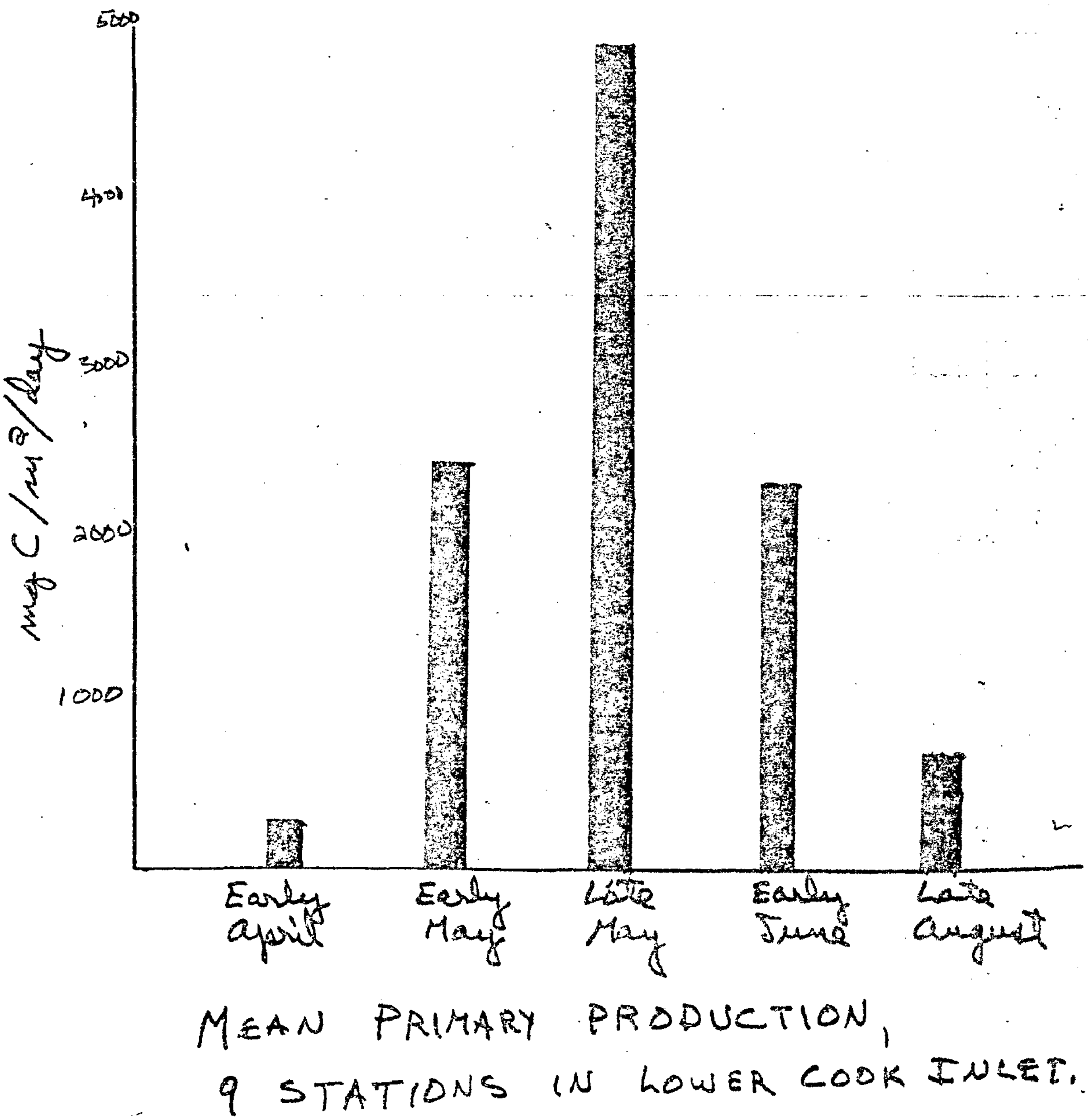

mg C/m²/day
5000
4000
3000
2000
1000
Early April
Early May
Late May
Early June
Late August
MEAN PRIMARY PRODUCTION,
9 STATIONS IN LOWER COOK INLET.

Figure 4

highest rates in late May were measured in the center of the inlet. The bloom in Kamishak Bay occurred in mid-July. Productivity rates for stations southeast of Tuxedni Bay are much reduced during spring-summer in comparison to more southerly stations. Other estimates in lower Cook Inlet range from 250-500 mg C/m^2/day (U.N. Food and Agriculture Organization, 1972). These productivity values appear higher than those measured in productive coastal waters of the Gulf of Alaska (Gulland, 1972). Phytoplankton production along open stretches of the Cook Inlet coast and in deeper waters not subject to upwelling processes is generally lower than for enclosed coastal areas. The role of phytoplankton advected in Cook Inlet from the Gulf of Alaska is not well understood but may contribute significantly to local productivity in the southern inlet.

Zooplankton communities in Cook Inlet are variously composed of year round populations which include copepods, chaetognaths and euphausiids, and seasonal residents such as crab, shrimp, clam, polychaete, and barnacle larvae and fish eggs. Recruitment to one of the most productive shellfish fisheries in the world in Kachemak Bay is totally dependent on high survival rates of the meroplanktonic (temporarily planktonic) crab and shrimp larvae and subsequent juvenile stages. Kachemak Bay, representing roughly 10% of the surface area of Cook Inlet, annually produces approximately 60% of the total shellfish tonnage caught in the inlet (Flagg, 1974). This fact underscores the indirect importance of the zooplankton to the regional economy of Cook Inlet. Similarly, the productive razor clam beaches on the east coast of the inlet from Anchor Point to Kasilof are maintained by the successful attachment of planktonic larval forms to the bottom. There appears to be a significant advective interchange of crustacean larval stages from Kachemak Bay to waters east of Augustine Island and possibly some input from the western side of the inlet to the Kenai Peninsula coast. Advection of larval stages into Cook Inlet from the Gulf of Alaska appears to be minimal (Haynes, 1976).

Zooplankton production reaches a peak during April-June, closely following the phytoplankton bloom period. Zooplankton biomass in Cook Inlet decreases considerably to the north of Kachemak Bay, with low populations present year round off Nikiski (Redburn, 1972) and in Turnagain Arm (Jackson, 1970). The NORPAC committee (1960) has estimated summer zooplankton densities of $400cm^3/1000m^3$ adjacent to the Barren Islands based on a survey in 1955. These values compare with a low survey value of $50cm^3/1000m^3$ for areas in the Gulf of Alaska to a summer high of $800cm^3/1000m^3$ for shelf regions of the Bering Sea, acknowledged as one of the most productive systems in Alaska. Damkaer (written commun.) compared zooplankton settled volumes from samples collected from several stations in Cook Inlet and the outside waters. Kachemak Bay showed the highest biomass ($31,000cm^3/1,000cm^3$), measured in early May (Fig. 5). April to August mean values in both the inlet and outside waters ranged from $500-10,000cm^3/1,000m^3$. Zooplankton biomass for most areas in lower Cook Inlet is probably lower than for the Barren Islands region.

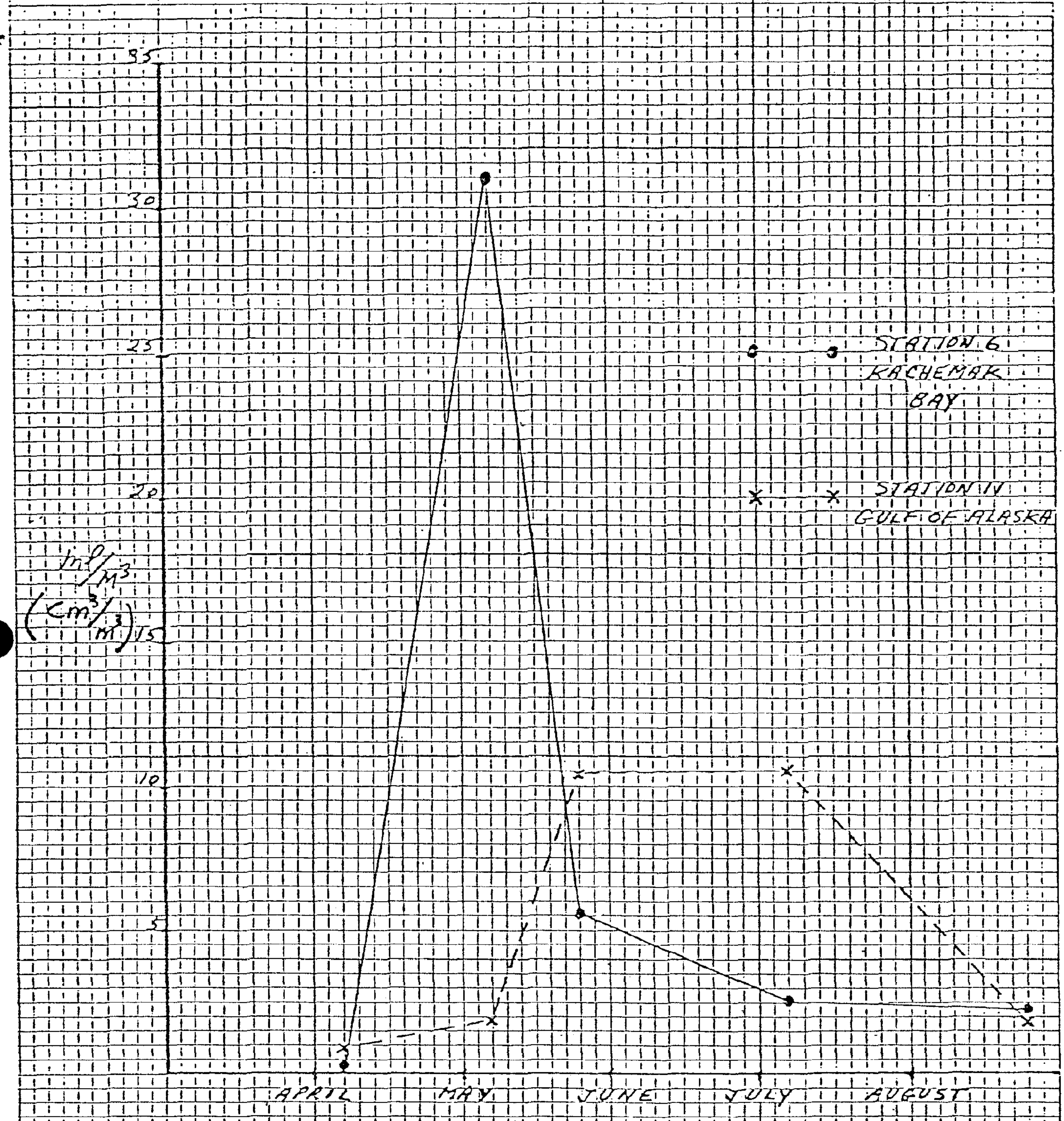


Figure 5. Zooplankton settled volumes, mean of all samples; Kachemak Bay (Station 6) and open ocean (Station 11); upper 25 m.

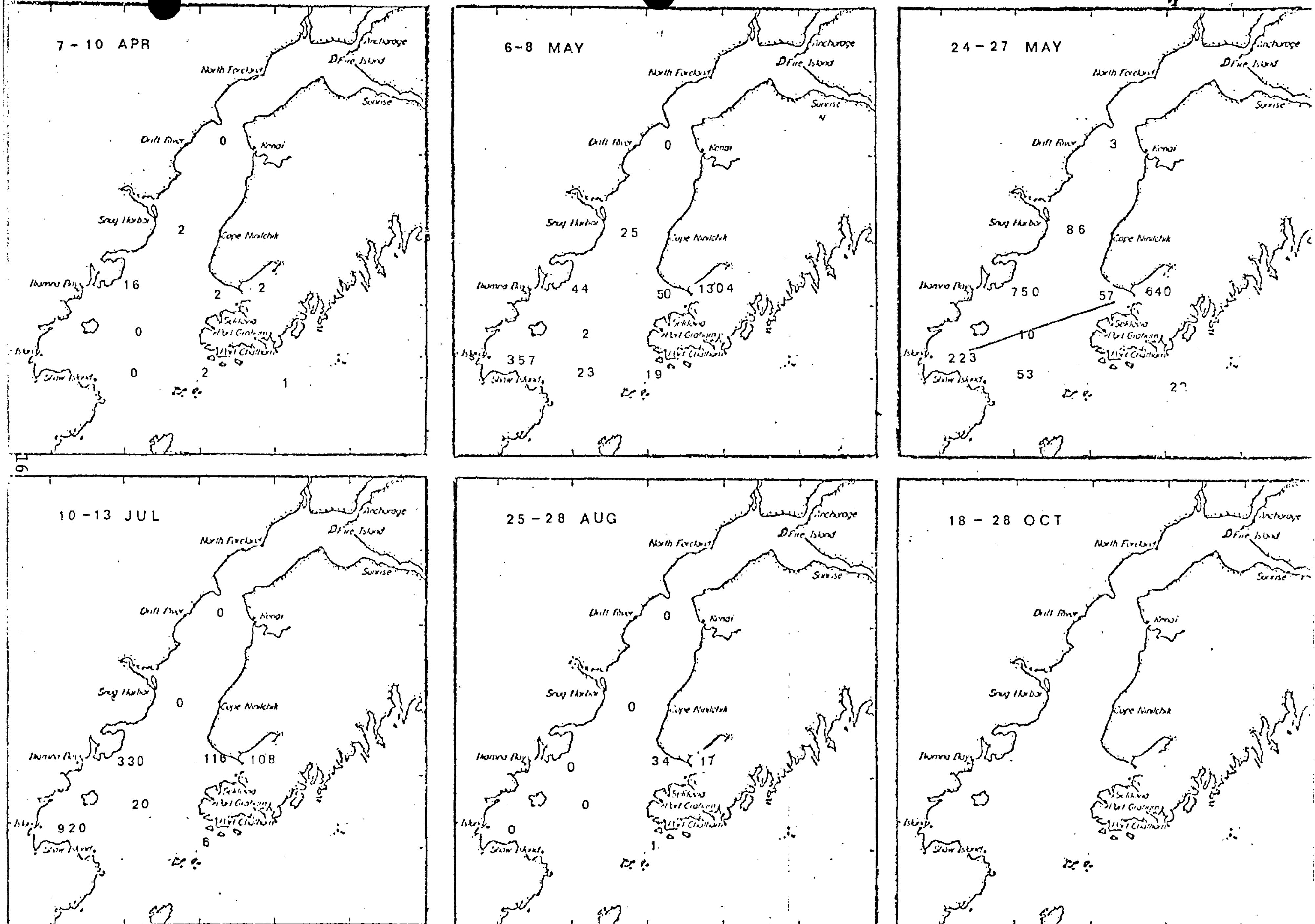
Total planktonic fish eggs are most abundant in lower Cook Inlet from early May through mid July (Fig. 6) with highest concentrations recorded from Kachemak and Kamishak bays and in waters northeast of Augustine Island (English, written commun.). Few eggs appear to be advected into the inlet from the Gulf of Alaska. No eggs were found in the plankton north of Anchor Point after mid July.

Marine macrophytes (attached seaweeds and eelgrass) are restricted to intertidal areas and subtidal waters receiving sufficient solar radiation to allow production in excess of metabolic requirements (Fig. 7). In clear Cook Inlet waters, where seaweeds flourish, this critical depth approaches 50 feet (Rosenthal and Winn, 1975). Significant macrophyte communities in waters north of Clam Gulch are much reduced or nonexistant (U.S. Dept. Interior, 1976; Alaska Dept. Environmental Conservation, 1976).

Quantitative surveys of intertidal and subtidal macrophyte communities in Cook Inlet are limited. The locations of major kelp beds have been documented by Rosenthal and Lees (Fig. 7). These large subtidal beds commonly consist of an upper canopy of <u>Alaria</u> and <u>Nereocystis</u> with an understory dominated by <u>Agarum</u> and <u>Laminaria</u>. Dames and Moore biologists (Lees, Rosenthal, and Winn, 1975) have recently conducted intensive intertidal and subtidal ecological investigations on the outer Kenai Peninsula in Kachemak Bay and at Spring Point, Chinitna Bay (Fig. 8). Habitat types observed included lagoons, exposed and protected intertidal zones, exposed subtidal, and semiprotected subtidal habitats. Investigations showed many protected lagoons to be rich in eelgrass; rocky habitats of the outer Kenai Peninsula and Kachemak Bay are particulary rich in algal specimens.

TOTAL FISH EGGS PER BONGO NET TOW

Figur



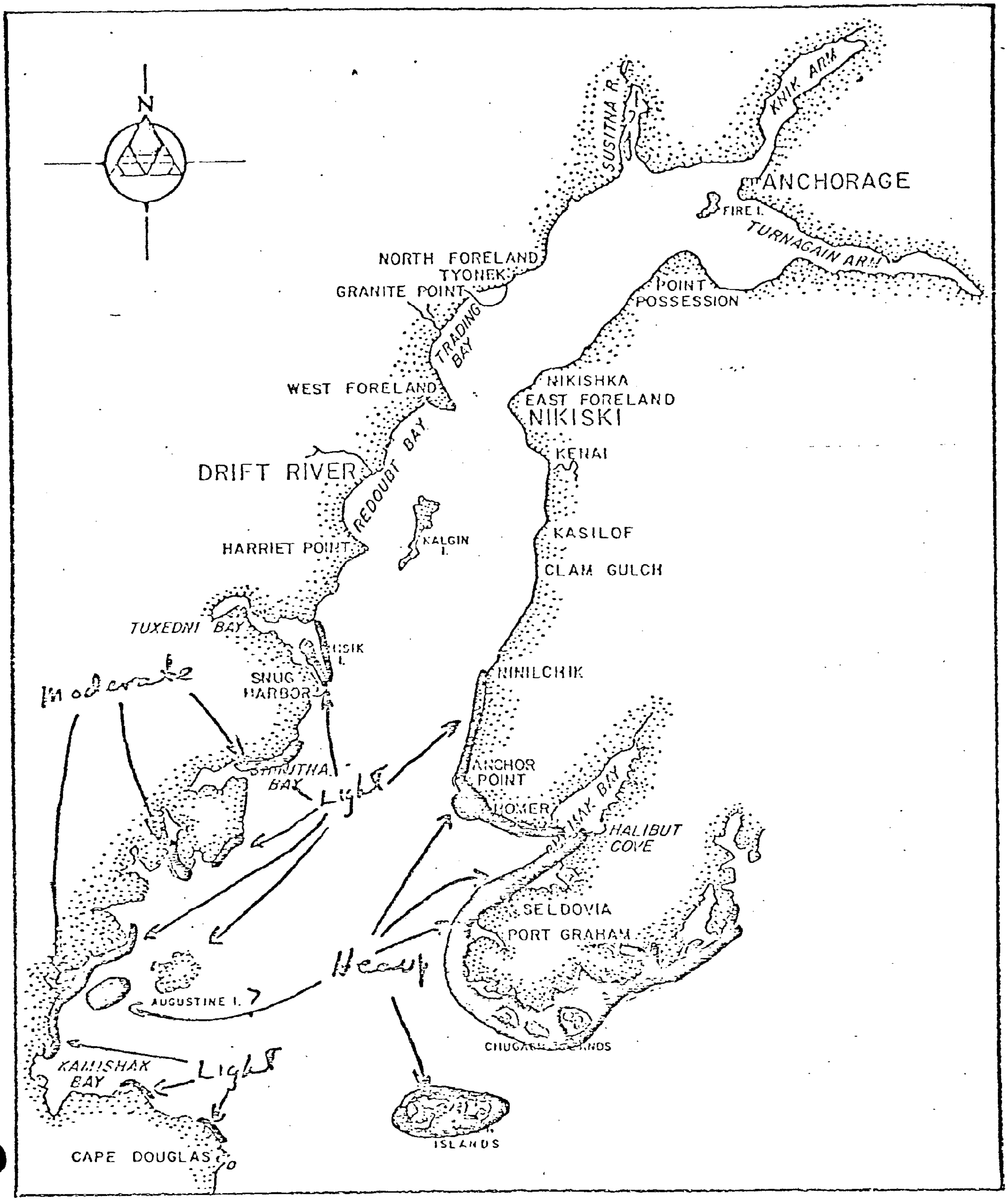
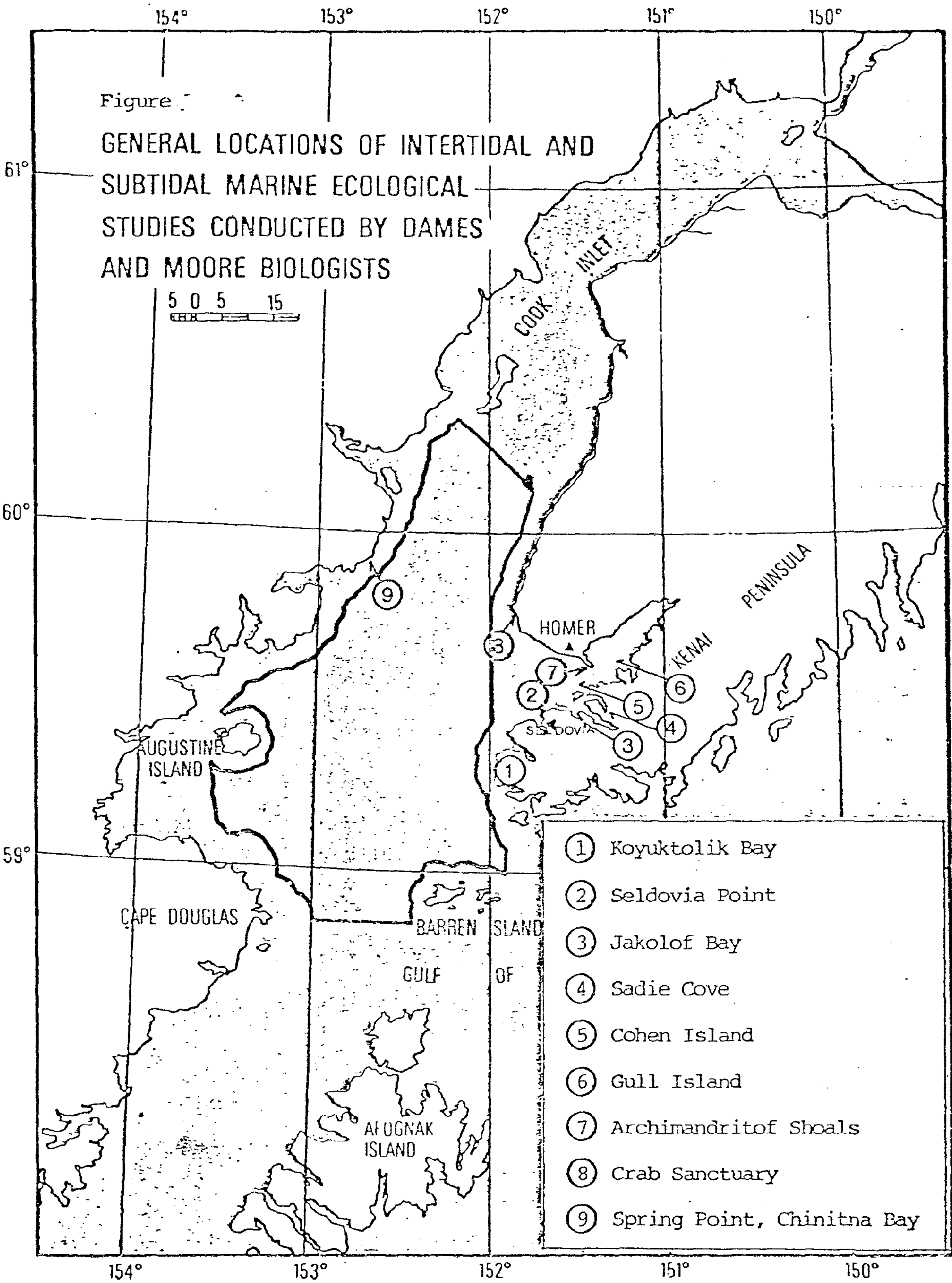


Figure 7. Benthic plant productivity--intertidal and subtidal.

Figure 8.



Source: USDI, Alaska OCS Office, Lower Cook Inlet Draft Environmental Impact Statement, Vol. I, 1976

Intertidal cover is slight to nonexistant north of Ninilchik (Alaska Dept. Environmental Conservation, 1976; U.S. Dept. Interior, 1976; Alaska Dept. Fish and Game, 1976). This condition results from both the largely unsuitable substrate (gravelly sand and sandy gravel) and the turbid waters of northern Cook Inlet. Only occasional drift specimens are found in the upper intertidal zone (primarily Fucus) indicating only marginal intertidal and subtidal populations exist. Markedly different conditions characterize Kachemak Bay. Windrows of drift algae are common along Hommer Spit and along inside shores of Kachemak Bay. Larger boulders in the low intertidal are relatively rich in the epilithic Ulva and Porphyra, with Balanus and Mytilus the dominant attached invertebrates.

Macrophyte distribution is generally continuous from the outer Kenai Peninsula to Ninilchik, excluding some parts of Kachemak Bay. Vegetative cover in the littoral zone of the western shore of lower Cook Inlet is not well documented. Attached marine plants show a discontinuous range from Chisik Island on all the headlands having stable substrates southward to Cape Douglas; Augustine Island and the Barren Islands support lush macrophyte stands (U.S. Dept. Interior, 1976). Intertidal algae cover in Kamishak Bay appears to be severely scoured by winter shore ice (Lees, pers. commun.). Most of the seaweed species found along the northern Gulf of Alaska coast are documented for Cook Inlet (Table 1), but specifics on their distribution are lacking.

Table 1 . Marine flora occurring along the North Gulf of Alaska Coast

Common Name	Generic Name	Description
Kelps	Family Laminariaceae Genera: Nereocystis Macrocystis	Brown algae Large Kelps reaching 100 ft in length found in deep water.
	Alaria	Large, leaf-like kelp reaching 70 ft in length and 2-6 ft in width. Common in Alaska.
	Laminaria Cymathaera Egregia Alaria Lessoniopsis Costaria Agarum	Kelps growing on rocks between high and low tide or just below low tide.
Rockweeds	Family Fucaceae Genera: Fucus	Occur between high and low tide and often completely cover rocky beaches.
Red algae	Genera: Gigartina Iridaea Porphyra Prionitis Rhodymenia Callopyllis Dasyopsis	Leaf-like body; live in low tide zone.
Green algae	Genera: Ulva	Sea lettuce; grown between high and low tide.
	Enteromorpha	Slender green algae occuring with or near Ulva.
Eelgrass	Genus: Zostera	Narrow ribbon-like leaves with rootstalks in muddy or sandy bottoms; can completely cover beach when exposed at low tide.
Sea basket grass	Genus: Phyllospadix	Rootstalks cling to rocks in heavy surf and exposed areas.
Saltwort	Genus: Salicornia	Fleshy plants abundant in salt marshes.

Rigg, G. B. 1942.

In: USDI, Alaska OCS Office, Lower Cook Inlet Draft Environmental Impact Statement, Vol. I, 1976

Macrophytes function as primary producers that are a source of food for herbivores and detritovores, provide shelter for smaller fish and invertebrates, substrate for reproductive products, and reduce erosion by stabilizing the shore. Macrophytes are grazed upon primarily by littorine snails and sea urchins and enter the detrital food web after decomposition to be consumed by filter and deposit feeding bivalves, amphipods and polychaetes. Juvenile tanner crabs and pandalid shrimp reportedly seek shelter near the holdfasts of large kelps (Rosenthal and Winn, 1975). Rich stands of seaweeds can be more than three times as productive as phytoplankton on an area basis, with rates approaching 1,800g C/m^2/year (Mann, 1973).

Eelgrass (Zostera marina) is a flowering vascular plant characteristic of soft sediments of the shallow subtidal zone of protected marine bays, inlets and lagoons. Distribution in Cook Inlet is disjunct (McRoy, 1968), with the only reported or likely extensive eelgrass locations on the Kenai Peninsula bordering the south side of Kachemak Bay, in fiords of the outer peninsula and nearby offshore islands (U.S. Dept. Interior, 1976) (Fig. A-1). Annual eelgrass beds have been observed in Kamishak Bay (Lees, unpubl. manuscr.). Distribution on the west coast is limited, presumably due to high turbidity and a number of interrelated contributory factors. Eelgrass is a very important energy source to waterfowl before breakup in spring and provides a food source for migratory waterfowl in summer and fall (McRoy, 1968).

Detrital input to the Cook Inlet system from the upper inlet may be significant to the trophic relationships of bottom communities in the southwestern inlet. Clumps of floating organic material locally called "grass," have been well documented for the Tyonek-Trading Bay region (Wright, pers. commun.). The fate of this potential food source is unknown.

Invertebrate groups commonly associated with intertidal/near subtidal ecosystems include grazers, filter feeders, detritovores (sea urchins, limpets, chitons, littorine snails, clams, polychaetes), and scavengers and carnivores (mussel drills, crabs, shrimp, sea stars). As with macrophytes, there exists an increasing gradient of invertebrate biomass to the south. Examples of the pathways of energy flow documented for the littoral and offshore zones of Cook Inlet are shown in Figures 9 and 10. Trophic interactions are complex and vary considerably between areas so that caution should be taken in making generalized interpretations.

Qualitative information on the structure of invertebrate communities in Cook Inlet has been provided for the Nikiski area by the Institute of Marine Science (Rosenberg et al., 1969). These surveys were largely restricted to the intertidal and near subtidal zone and were not quantitative. Additional invertebrate surveys have been conducted in Kachemak Bay, the outer Kenai Peninsula, and from Kenai to Anchor Point (Lees and Rosenthal, 1975; Alaska Dept. Environmental Conservation, 1976).

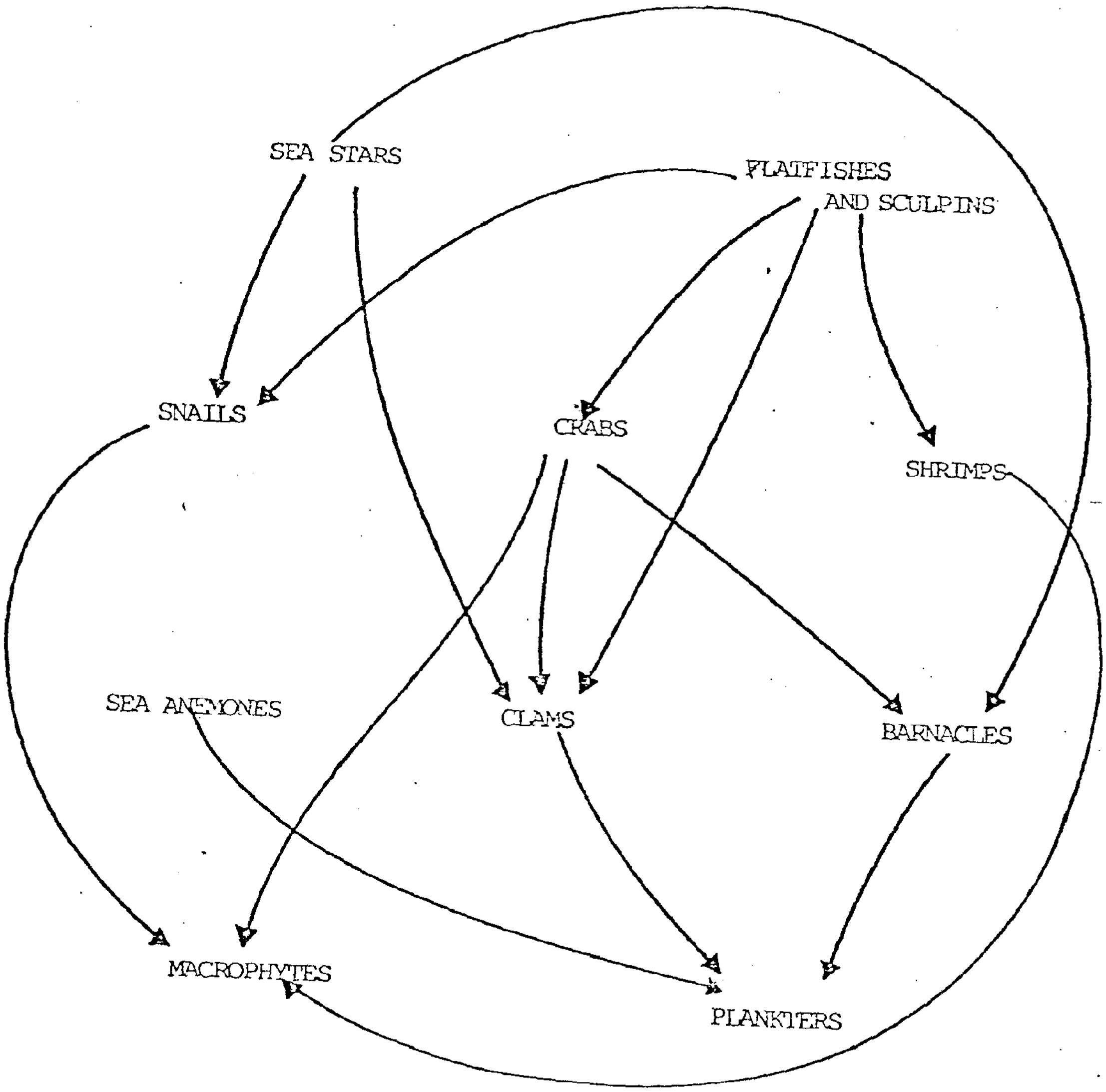


Figure 9.

Generalized food web depicting energy flow at the head of Sadie Cove, Kachemak Bay.

Source: Rosenthal (1975)(Modified)

In: USDI, Alaska OCS Office, Lower Cook Inlet Draft Environmental Impact Statement, Vol. I, 1976

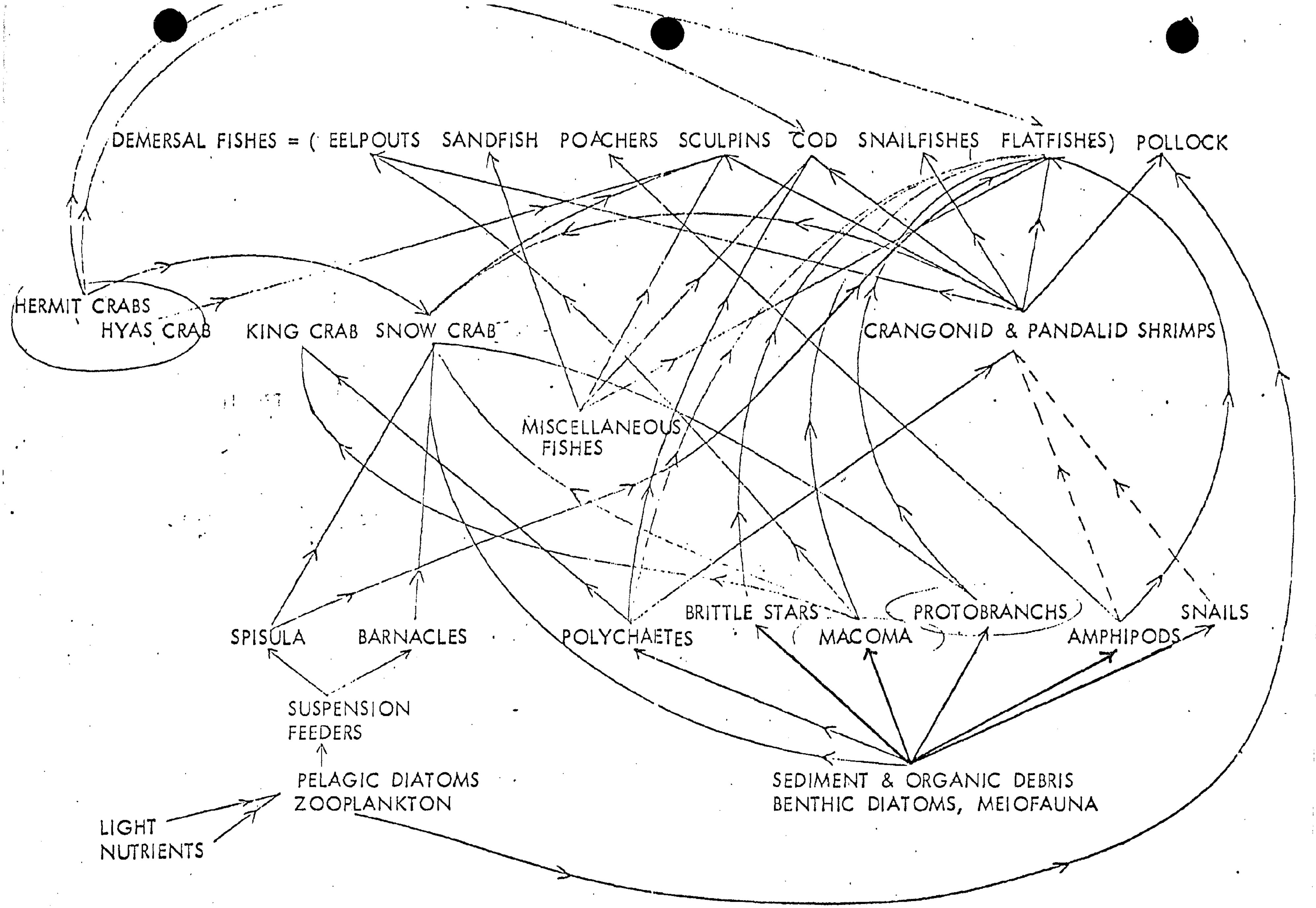


Figure 10. Offshore, demersal food web for Lower Cook Inlet (from Feder, 1976).

Rosenberg et al. (1969) sampled benthic fauna at Salamatof, Nikishka Bay, and Kalifonsky beaches. Forty-six taxa were recorded from the two-year survey with amphipods and isopods dominant in May with trends toward greater community diversity in July and September of 1968. Kalifonsky beach was more productive than the other beaches surveyed. The reduced invertebrate biomass and diversity on beaches was attributed to the effects of sedimentation along the shoreline.

The Alaska Department of Fish and Game sampled subtidal and intertidal invertebrate communities near the Standard Oil exploratory drilling site south of Cape Kasilof. Flagg et al. (1974) reported significant numbers of juvenile tanner crab and small razor clams in offshore sediments and suggest the Cape Kasilof area may be of critical importance to the postlarval stages of razor clams. Other fauna sampled included whelks, starfish, barnacles, chitons, and pink, humpy, and hippolytid shrimp. Hermit, tanner, and spider crabs were particularly abundant. Table 2 lists common intertidal flora and fauna at other select sites in Cook Inlet (Jackson, 1970). Lees and Rosenthal (1975) reported few sea urchins and sea stars in the subtidal zone north of Anchor Point. This distribution appears to be correlated to low kelp and mussel biomass.

The distribuiton and abundance of deep-water benthos in Cook Inlet has been superficially documented. Information on noncommercial benthic populations has come primarily from "incidental catches" in July-September trawl surveys conducted over several years by the National Marine Fisheries Service (Fig.11) and grab and trawl sampling by Feder (viva voce). Areas of high biomass are not continuous over a broad area, rather, they are distributed in "patches." Deposit feeders appear dominant in substrates

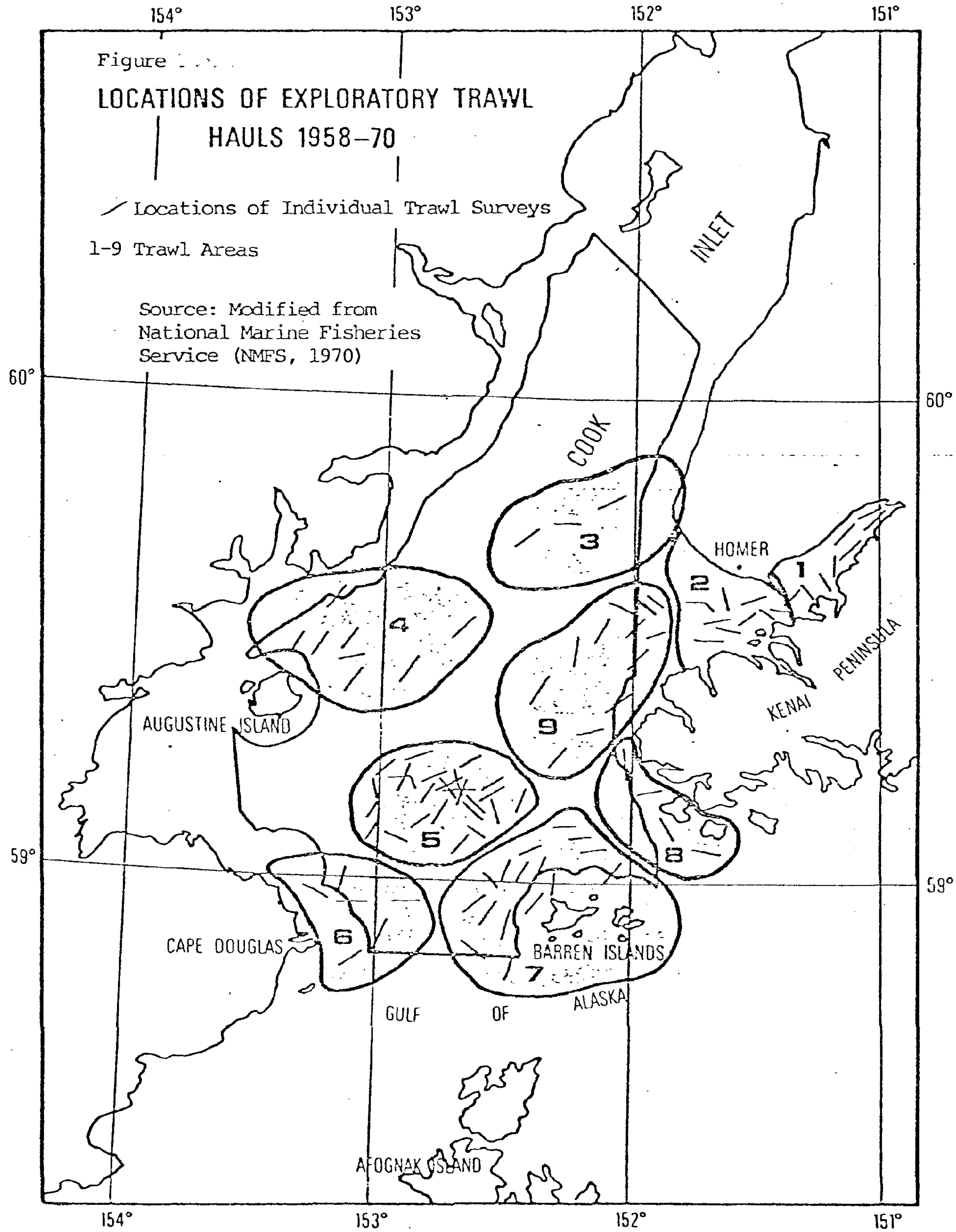
Table 2. Common intertidal fauna and flora in Cook Inlet.

Knik Arm	Turnagain Arm	Kalifonsky Beach
Vaucheria	Amphipods	Amphipods
Cladophora	Decapods	Decapods
Ulothrix	Fucus	Mytilus
Enteromorpha		Acorn Barnacles
Oscillatoria		Clams
Flatworms		Sea Anemones
Oligochaetes		Snails
Nematodes		Brown Algae
Amphipods		
Decapods		
Diptera		

Source: Jackson 1970.

In: USDI, Alaska OCS Office, Lower Cook Inlet Draft Environmental Impact Statement, Vol. I, 1976

Figure 11.



In: USDI, Alaska OCS Office, Lower Cook Inlet Draft Environmental Impact Statement, Vol. I, 1976

of the western inlet, while suspension feeders predominate along the east side (Feder, pers. commun.). Detritus undoubtedly plays a major role in benthic food webs of the western inlet (Kamishak, Augustine Island areas) as the reduced currents in the area allow for substantial detrital "fallout".

Invertebrate biomass reported from trawl areas depicted in Figure 11 is summarized by BLM (U.S. Dept. Interior, 1976). Areas 3 and 4 contained low to moderate quantitaties of sea squirts, mussles, and sea urchins. Large numbers of tanner crab (1,000-3,000 individuals) and king crab (800 individuals per 1-hour tow) were taken in area 5. Trawls in area 6 and the eastern part of area 7 have yielded very large concentrations of tanner crabs. Area 7 is notable for its diversified fauna. Large amounts of brittle stars, sea cucumbers, and sea urchins were common with generally few shrimp. Trawls from area 8 have produced enormous amounts of brittle stars and sea urchins. More than 200 brittle stars have been recorded from a standard 1-hour trawl; this trawl also yielded 3,500 pounds of sea urchins. Catches in area 9 indicate a diverse composition, with mussels, sea urchins, and immature scallops found in abundance.

Feder (pers. commun.) reported concentrations of adult and juvenile tanner crab northeast and southwest of Augustine Island, with highest abundance of juveniles east of Cape Douglas. The sandy-mud substrates in deep waters east of Augustine Island support rather substantial populations of detritovore deposit feeders.

Catch statistics (tonnage, catch per unit of effort) available from Federal and State agency files are useful indices in assessing the productivity of the mobile, commercially-important shellfish and other benthic epifauna in Cook Inlet. The distribution of major commercial shellfish grounds are depicted in Figures A-3 and A-8; they give some feeling for gradients in abundance for these species. Upper Cook Inlet (north of Kalgin Island) does not support a shellfish fishery.

Tidal and Contiguous Fresh Water Wetlands

Tidal wetlands are transitional areas between marine and terrestrial ecosystems. They are areas of low relief and low gradient between approximately mean low water and the highest extent of the tides. Tidal wetlands are characterized by the presence of salt-tolerant vegetation. Many tidal wetlands have meadowlike appearances because of the low diversity of sedges and grasses which grow on them. Tidal and contiguous supratidal freshwater wetlands are areas of complex biological interactions and constitute essential or valuable habitat for many species of fish, birds, and mammals. As the result of differences in topography, wetlands on the west and east sides of lower Cook Inlet differ.

Along the coast north of Kachemak Bay, tidal wetlands occur only at the mouths of streams (Table 3). A beach berm or spit protects them from erosion and wave damage. Such wetlands are near the communities of Anchor point (Fig.C-5), Ninilchik (Fig.C-4), Kasilof (Fig.C-2), and Kenai (Fig.C-1). In Kachemak Bay, major tidal and fresh water wetlands are present on the Fox River delta. Along the south shore of Kachemak Bay, a few tidal wetlands of modest size are present behind spits and beach berms which protect them from wave attack from the southwest. These occur in Aurora Lagoon, at the mouth of the Grewingk outwash plains, the mouth of Halibut Creek in Halibut Cove, throughout most of China Poot Bay, and on McKeon Flats (Alaska Dept. Environmental Conservation, 1976).

South and west of the mouth of Kachemak Bay, small tidal wetlands occur at the mouth of Seldovia River and behind Point Naskowhak across the inlet from Seldovia (Fig.C-8). In Port Graham small tidal wetlands occur near the head of the inlet (Fig.C-9).

Table 3. Tidal wetlands of the eastern shore of lower Cook Inlet.*

Location or Vicinity	Approximate Square Miles Of Wetlands
Port Graham	0.1
Seldovia River and Naskowhak Point	0.3
McKeon Flats	0.6
China Poot Bay	2.2
Halibut Cove	0.5
Grewingk Creek	1.1
Aurora Lagoon	0.7
Fox River	8.2
Homer	0.3
Anchor River	0.1
Deep Creek	0.1
Kasilof River	2.1
Kenai River	3.5

*Adjacent freshwater marshes not included in compilations because of indefinite inland boundaries.

Source: Unpublished manuscript, Alaska Department of Environmental Conservation, 1976.

On the western coast of Cook Inlet, McArthur Flats in Trading Bay (Fig. C-11) and Bachatna Flats in Redoubt Bay (Fig. C-14) are extensive areas of fresh water wetland landward of a tidal wetland fringe. Further south, the mountains of the Aleutian Range and the deep fiords restrict the size of tidal and contiguous freshwater wetlands. However, many of the bays and inlets have extensive mud flats, most probably backed by fringes of tidal and contiguous freshwater wetlands (Table 4).

Wetlands are important from both an ecological and an economic standpoint. They are critical to the survival of many species that do not depend directly on wetlands but are indirectly tied to their maintenance. Brown and black bears use wetlands for early foraging during spring before availability of other food and for salmon fishing in the summer and fall. During winter, lowland range is critical for game species like moose. Their range extends to the tidal and immediately adjacent freshwater wetlands. The beach fringe in many areas is important for grazing animals during severe winters.

Larger carnivores such as wolves and wolverines are present throughout much of lower Cook Inlet, including wetlands. Smaller carnivores such as lynx, red fox, mink, weasel, marten, and coyote (Alaska Dept. Fish and Game, 1976) are also commonly found in these areas. They prey on smaller mammals that inhabit the supratidal marshes and feed on carrion carried onto shore by the tides. Some carnivores also make heavy use of spawned salmon carcasses in the waterways of the wetlands.

Table 4. Locations of tidal wetlands of unknown extent on the west shore of lower Cook Inlet

Location
Trading Bay
McArthur Flats
Redoubt Bay
Bachatna Flats
Fox Flats
Little Jack Slough
Iniskin Peninsula
Cottonwood Bay
Iniskin Bay
Oil Bay
Chinitina Bay
Iliamna Bay
Kamishak Bay
Bruin Bay
McNeil Cove
Horseshoe Cove
Pinkidulia Cove
Akumwaruik Bay

Source: Unpublished manuscript, Alaska Department of Environmental Conservation, 1976.

Seabirds and waterfowl use wetlands for overwintering, nesting, feeding, molting, staging, and resting during migration. Wetlands also serve many essential purposes in maintaining water quality and enhancing the surrounding environment. They serve as biological nutrient filters and settling areas for silt, sediments, and some types of pollution. Energy fixed by wetland plants, released by their death and decay during the fall and winter, is transported seaward where it contributes to the food web of near-shore communities.

Wetlands in their natural state have many other beneficial and economic uses for man. They offer recreational opportunity and access to beaches and the sea. This is especially true in those parts of Cook Inlet that have little other flat, grassy land and beaches. Their visual relief is a change from wooded or mountainous shores. Waterfowl populations also provide hunting opportunities and fish are accessible to shore-bound sport fishermen. Many species of edible plants and berries grow on the supratidal areas immediately adjacent to tidal wetlands. The open scenery on larger wetlands is appealing to photographers, sightseers, and naturalists.

Tidal and fresh water wetlands in Alaska and the rest of the United States have been intensively used for aggregate borrow sites, building sites for large facilities and industries which require flat open space, dumps for wastes, and highway beds. Many communities are built on river deltas and former wetlands because of availability of fill and aggregate material, fresh water sources, and easily worked substrate for port facilities and construction of transportation routes. Unfortunately, modifying wetlands for some human uses may be disadvantageous. In the course of development, valuable scenic, wildlife, and other ecological values are modified or destroyed. This may be especially saddening in locales where such land is a rare commodity. Reclamation is a costly process. Moreover, the substrate upon which many wetlands lie are only marginally suited for construction. Many coastal towns in Alaska have felt the consequences of building on deltas and other locales underlain by unconsolidated sediments. In the absence of catastrophic events, subsidence due to settling of shifting of fill, or the seasonal rising and falling of an already high water table often results in flooding, problems with water supply and disposal, and added expenses for maintenance. Mudslides or fluvial and storm flooding on a larger scale are continuing threats to many communities built on deltas or alluvial fans.

In general, the modification of wetlands often results in less than optimum solutions to human problems. The recently expanded jurisdiction of the Corps of Engineers over dredge and fill operations in wetland areas, and the efforts of many coastal states to maintain their remaining wetland areas are evidence of a new national conciousness of the value of these areas.

Fish and Wildlife Resources

Fish and wildlife resources in lower Cook Inlet include finfish and shellfish, terrestrial and marine mammals, waterfowl and seabirds.

Commercially exploited finfish in Cook Inlet include all five species of salmon, halibut, and herring. Major salmon spawning streams are indicated in Figures B-1 to B-12. Major runs of pink and chum salmon escape to spawning drainages along the south coast of the outer Kenai Peninsula, and sockeye, chinook, and coho salmon migrate up the east side of the inlet in substantial numbers. Salmon escapements to Cook Inlet begin with chinook in late May - early June and terminate with the coho migration in late August (U.S. Army Corps Engineers, 1973). Outmigration commences as early as mid May and lasts through August.

Halibut concentrations are found in Cook Inlet from Kalgin Island south from May through August (Evans et al., 1972) (Figs.A-1,A-5). Fishing effort is concentrated during these months primarily in Kachemak Bay. Most halibut populations overwinter in outside waters.

Seasonal directional migrations appear to characterize the life history of several species of demersal fish in Cook Inlet (Blackburn, written commun.). Butter sole and halibut apparently undergo spawning migrations to the eastern waters of the inlet in June and return to deeper waters east and north of Augustine Island, respectively, as summer progresses (Figs. 12 and 13). Areas east of Augustine Island appear to have very low bottom currents. Tanner crab were also found to be most concentrated east of Augustine Island.

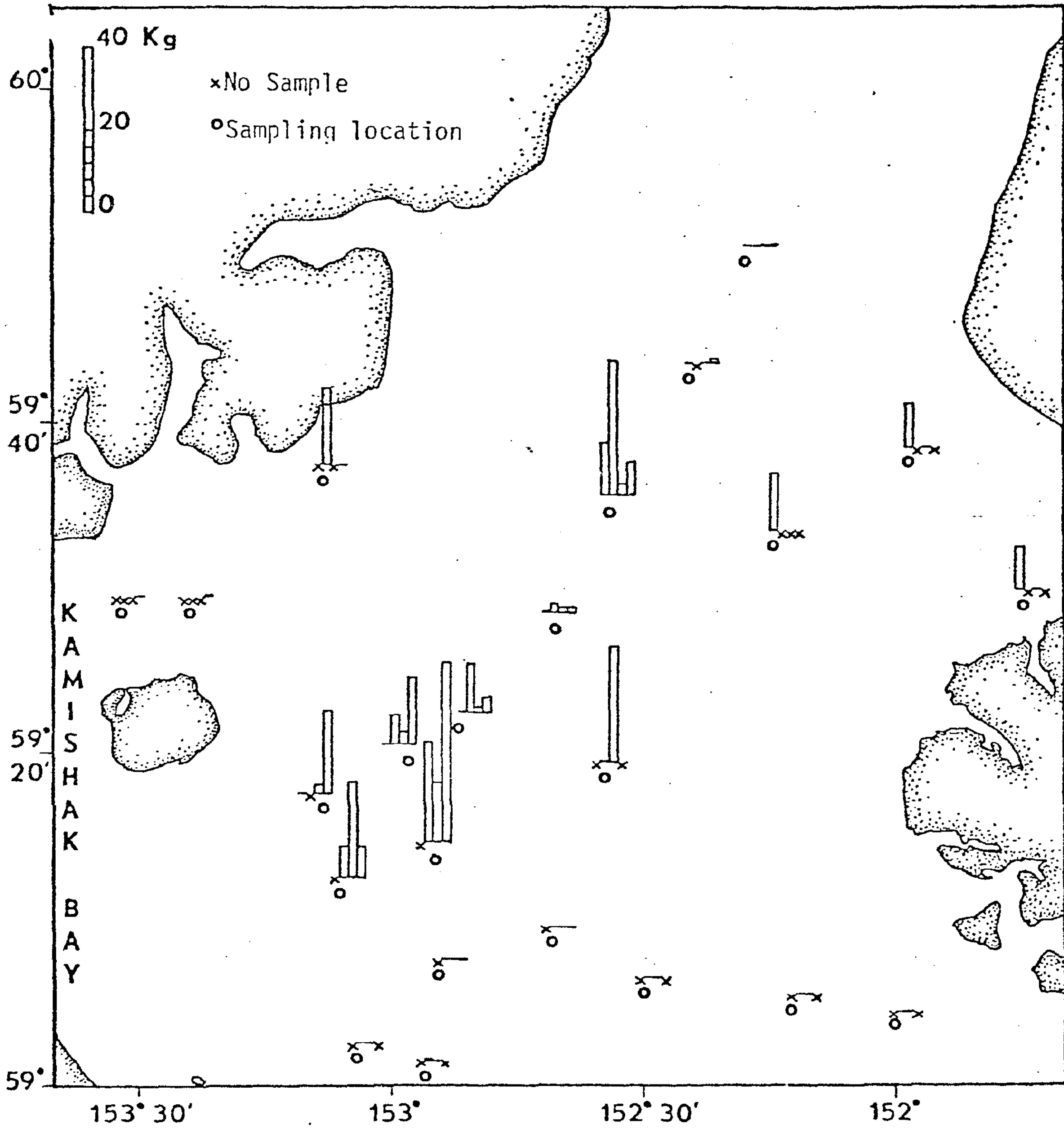


Figure 12. Preliminary presentation of 20 minute otter trawl catch of butter sole (*Isopsetta isolepis*) in Kg by location and month. Catches in early June, July, August and September are shown left to right respectively for each location. Jim Blackburn, Box 686, ADF&G Kodiak, Ak. 99615; Nov. 15, 1976.

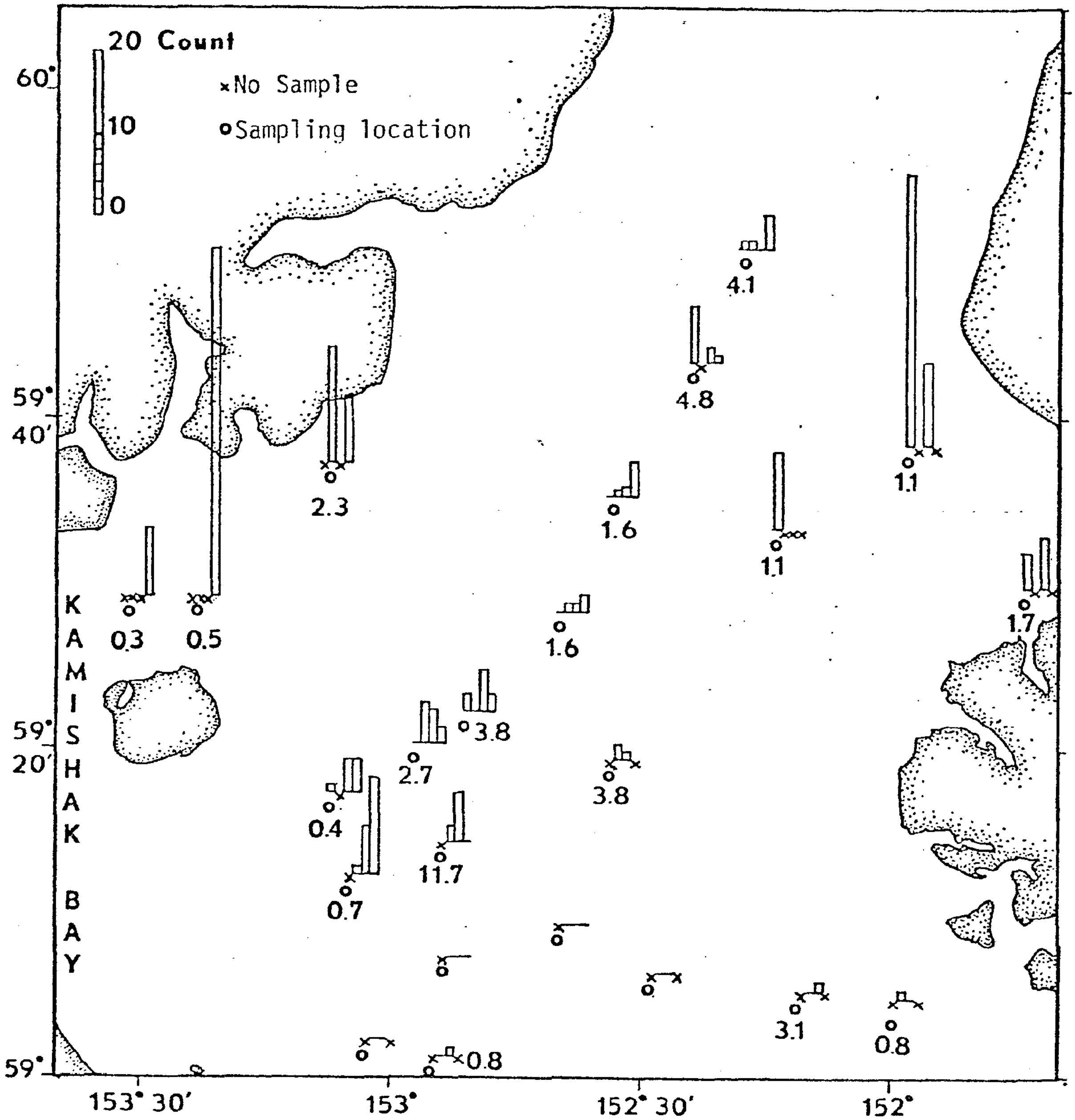


Figure 13. Preliminary presentation of 20 minute otter trawl catch of Pacific halibut (*Hippoglossus stenolepis*) numbers by location and month. Catches in early June, July, August and September are shown left to right respectively and mean weight in Kg is given for each location Jim Blackburn, Box 686, ADF&G, Kodiak, Ak. 99615; Nov. 15, 1976.

Herring harvests in Cook Inlet have been substantial, with catches approaching 20 million pounds in 1915 (U.S. Army Corps Engineers, 1973). Herring are most abundant in Kachemak Bay with active spawning in areas along the south shore of the bay.

Dolly Varden, steelhead, and rainbow trout are important sport fish in many lower Cook Inlet streams. Major runs of anadromous Dolly Varden populations occur from July to mid October. Steelhead distribution is disjunct in the inlet; significant populations occur in Anchor River. Adult escapement lasts from mid August to mid October.

Shellfish of commercial importance in lower Cook Inlet include five species of pandalid shrimp, Dungeness, tanner, and king crab, scallops, and razor clams. Dungeness crab are taken almost entirely from Kachemak Bay in bays and estuaries near the coast. They are caught in the intertidal zone and to depths of 50 fathoms (Hoopes, 1973). Shrimp are likewise taken from the bay as well as in deeper waters east of Cape Douglas (Figs. A-3, A-4). Tanner and king crab are landed primarily in the deeper waters of the southern inlet, between Augustine and the Barren Islands (Figs. A-8, A-9) and north of Seldovia. King crab are apparently highly migratory in Cook Inlet. Flagg (1972) reports much of the winter fishery in Kachemak Bay is based on transient crabs that migrate from near the Barren Islands and Kodiak during late summer and fall. Other populations are resident to Kachemak Bay. The Bluff Point area at the mouth of Kachemak Bay appears to be a primary release point for crab and shrimp larvae. It also appears that early zoeal development stages are concentrated in this area by a current gyre until the larvae settle to the bottom as juveniles. Zooplankton sampling and benthic surveys have confirmed the area to be the most productive shellfish larval area in Kachemak Bay (Haynes, 1976; Alaska Dept. Fish Game, 1975). The Alaska State Legislature established the Bluff Point Crab Sanctuary in 1974 in recognition of this critical habitat.

Razor clam beaches are found along the surf-swept beaches of the east coast from the Homer Spit to Kasilof and north of Tuxedni Bay on the western shore of Cook Inlet. Scallops are trawled in deep water (30-70 fathoms) east of Augustine Island.

Distributions of larger terrestrial mammals in Cook Inlet are denoted in Figures B-2--B-12. Moose are abundant throughout most of the Kenai Peninsula and western Cook Inlet with major spring-summer and wintering concentration areas at the head of Kachemak Bay and in the Kenai National Moose Range. Coastal concentrations of black bear are found at the head of Kachemak Bay and from Tuxedni Bay north to Redoubt Bay; brown bear are found throughout lower Cook Inlet with intensive spring use of Redoubt Bay. Caribou calving grounds are present east of Nikiski. Wildlife species common to the western coast of Cook Inlet include wolf, brown and black bear and moose (Alaska Dept. Fish Game, 1973). Brown and black bear ranges overlap in Redoubt Bay area.

Significant sea otter populations are found around Augustine Island and Cape Douglas and in embayments along the outer Kenai Peninsula (Alaska Dept. Fish Game, 1973). Schnieder (1975) reports that about 1,000 otters are distributed along the western side of the inlet from Shakum Rocks to

Chinitna Point. High populations (approximately 1,000) inhabit the Barren Islands. East coast populations probably number several hundred, with a gradual range expansion to the north of Kachemak Bay.

Harbor seals are found along the entire west coast of the inlet with concentrations at the north of the Susitna River and off Augustine and Shaw islands. High populations exist on Yukon Island in Kachemak Bay and in the Barren Islands (Alaska Dept. Fish Game, 1973). Tuxedni Bay and Kalgin Island also host high population densities. Harbor seals are seldom abundant north of Kachemak Bay on the east side of the inlet.

Sea lions are most highly concentrated in the Barren Islands (6,000-10,000 individuals). Pupping occurs primarily on the Sugar Loaf Island rookery from June to July (U.S. Army Corps Engineers, 1973). Numerous smaller rookeries exist along the southern coast of the outer Kenai Peninsula. Beluga whale populations in Cook Inlet have been estimated at 300-400 (Klinkhart, 1966), with runs found as far north as the Susitna River, presumably drawn to the area to prey upon salmon smolt and adults. Killer whales and Dall and harbor porpoises are also occasional visitors to lower Cook Inlet.

Waterfowl and shorebird populations in Cook Inlet are concentrated at the head and southwestern portions of Kachemak Bay, the Susitna River Flats, Kalgin Island, Trading Bay, and Redoubt Bay. The coastal areas of Kalgin Island have been designated as a Critical Waterfowl Habitat area by the Alaska State Legislature. Waterfowl use of coastal lowlands, bays, and estuaries is highest during the spring and fall migration periods. Early spring mortality may be high due to severe winters which extend ice breakup and preclude coastal feeding. Ducks, geese, and swans are major segments of total bird populations in these wetlands, approaching 1.0 million individuals throughout Cook Inlet. Kachemak Bay, the coast of the outer Kenai Peninsula, and Chinitna Bay south to Cape Douglas are identified as prime wintering habitat for sea ducks, larids, and shorebirds (Alaska Dept. Fish Game, 1973). The entire eastern shore of Cook Inlet receives some use as nesting/molting habitat, as does Kalgin Island and areas north of Chinitna Bay.

Major seabird colonies are reported from Chisik Island (75,000 birds), Tuxedni Bay, Chinitna Bay, and from several islands off the outer Kenai Peninsula. Kamishak Bay supports approximately 8,000 breeding birds. Additional colonies in lower Cook Inlet with species and population estimates are listed in Table 5. Particularly high concentrations of seabirds (primarily shearwaters and puffins) are present in the Barren Islands area (500,000 breeding birds) from May through September (U.S. Dept. Interior, 1974).

Aerial transects by Sowl and Evans (1972) in August, 1972 showed lower seabird densities (27 birds/km^2) in the upper portion of lower Cook Inlet (Kalgin Island region) as compared to densities observed around the mouth of the inlet (482 birds/km^2). Pelagic areas in lower Cook Inlet during winter months appear to receive comparatively little bird use.

TABLE 5*

A LIST OF KNOWN SEABIRD COLONIES
LOCATED IN LOWER COOK INLET, ALASKA

Reference Number to Graphic 5	Nameplace	Species	Population Estimates	
1.	Upper Tuxedni Bay	Black-legged Kittiwake	NE	(B&S)
2.	Duck Island & Rocks	Black-legged Kittiwake	NE	(S)
		Common Murre	NE	(S)
3.	Chisik Island (4 Colonies)	Black-legged Kittiwake**	45,000	(K)
		Glaucous-winged Gull	2,000	(S)
		Horned Puffin	5,000	(S)
		Tufted Puffin	1,000	(S)
		Parakeet Auklet	PR	(S)
		Kittlitz's Murrelet	PR	(S)
		Marbled Murrelet	PR	(S)
		Pelagic Cormorant	PR	(S)
		Double-crested Cormorant	500	(S)
		Common Murre	25,000	(S)
4.	Tuxedni Channel	Black-legged Kittiwake	NE	(S)
5.	Glacier Spit	Cormorants	NE	(ADF&G)
		Glacuous-winged Gull	NE	(ADF&G)
6.	Gull Island	Black-legged Kittiwake	NE	(ADF&G)
		Murres	NE	(ADF&G)
		Pigeon Guillemot	NE	(ADF&G)
7.	Iniskin Island*	---	--	(W)
8.	Knoll Head*	---	--	(W)
9.	South Head*	---	--	(W)
10.	Ursus Cove*	---	--	(W)

*From U.S. Department of Interior, 1976.

Table 5 cont.

Reference Number to Graphic 5	Nameplace	Species	Population Estimates	
11.	Fortification Bluff*	---	---	(W)
12.	Contact Point 1	Cormorants	NE	(W)
13.	Nordyke Island	Cormorants	NE	(W)
14.	Akjemjuiga Cove*	---	---	(W)
15.	Horseshoe Cove*	---	---	(W)
16.	Augustine Island	Several Species	NE	(B&S)
17.	Ushagat Island	Pigeon Guillemot	100	(B)
		Glaucous-winged Gull	240	(B)
		Horned Puffin	250	(B)
		Tufted Puffin	100	(B)
		Parakeet Auklet	10	(B)
		Cormorant	200	(B)
18.	Carl Island	Horned Puffin	40	(B)
		Tufted Puffin	1000	(B)
		Cormorants	50	(B)
19.	Sud Island	Red-faced Cormorant	70	(B)
		Horned Puffin	400	(B)
		Tufted Puffin	1000	(B)
		Pigeon Guillemot	PR	(B)
		Parakeet Auklet	20	(B)
		Glaucous-winged Gull	500	(B)
		Fork-tailed Petrel	NE	(B)
		Rhinoceros Auklet	1000	(B)
20.	Nord Island	Black-legged Kittiwake	20,000	(B)
		Parakeet Auklet	400	(B)
		Glaucous-winged Gull	80	(B)
		Common Murre	30,000	(B)
		Pigeon Guillemot	PR	(B)
		Horned Puffin	PR	(B)
		Tufted Puffin	5000	(B)
		Cormorants	40	(B)
21.	West Amatuli	Tufted Puffin	93,000	(B)
		Horned Puffin	1,300	(B)
		Common Murre	PR	(B)
		Forked-tailed Petrel	NE	(B)
		Cormorants (3 species)	870	(B)
		Glaucous-winged Gull	2,300	(B)
		Black-legged Kittiwake	300	(B)
		Pigeon Guillemot	70	(B)
		Parakeet Auklet	120	(B)
		Fulmar	PR	(B)

Table 5 - cont.

Reference Number to Graphic 5	Nameplace	Species	Population Estimates	
22.	East Amatuli	Common Murre	61,000	(B)
		Thick-billed Murre	NE	(B)
		Fulmar	PR	(B)
		Glaucous-winged Gull	450	(B)
		Black-legged Kittiwake	13,000	(B)
		Cormorants (3 species)	PR	(B)
		Fork-tailed Petrel	NE	(B)
		Kittlitz's Murrelet	NE	(B)
		Parakeet Auklet	360	(B)
		Pigeon Guillemot	50	(B)
23.	Sugarloaf Island	Cormorants (3 species)	240	(B)
		Fork-tailed Petrel	NE	(B)
		Glaucous-winged Gull	1600	(B)
		Pigeon Guillemot	PR	(B)
		Horned Puffin	600	(B)
		Tufted Puffin	9500	(B)
24.	Elizabeth Island	Cormorants	NE	(B&S)
25.	Perl Island	Black-legged Kittiwake	5000	(B&S)
		Cormorant	300	(B&S)
		Tufted Puffin	NE	(B&S)
26.	East Chugach Island	Glaucous-winged Gull	1000	(B&S)
		Cormorant	300	(B&S)
		Tufted Puffin	NE	(B&S)
27.	Rocky Bay	Glaucous-winged Gull	25,000	(B&S)
		Black-legged Kittiwake	10,000	(B&S)
28.	Port Dick	Cormorant	1,500	(B&S)
		Glaucous-winged Gull	500	(B&S)
29.	Gore Point	Black-legged Kittiwake	1,000	(B&S)
		Cormorants	NE	(B&S)
30.	Sixty-foot Rock*	Puffins	NE	(D)

Table 5. cont.

Reference Number to Graphic 5	Nameplace	Species	Population Estimates	
31.	Gull Island	Red-faced Cormorant	NE	(S)
		Pelagic Cormorant	NE	(S)
		Double-crested Cormorant	NE	(K)
		Black-legged Kittiwake	NE	(K)
		Arctic Tern	NE	(S)
		Thick-billed Murre	NE	(S)
		Common Murre	NE	(K)
		Pigeon Guillemot	NE	(K)
		Horned Puffin	NE	(K)
		Tufted Puffin	NE	(K)
		Glaucuous-winged Gull	NE	(S)
		Herring Gull	NE	(S)
32.	Glacier Spit	Cormorants	NE	(K)

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* Suspected nesting colony

** Snarski estimated 45,000 black-legged kittiwakes inhabit all colonies in the Tuxedni Bay region.

NE No Estimate

PR "Present" indicates those species whose estimated numbers were 49 or less.

Sources: Bartonek and Sowl, 1972 (B&S)
Krohn, 1966 (K)
de Laguna, 1934 (D)
Snarski, 1971-73 (S)
Bailey, 1975 (B)
Wohl, Pers. Comm. (W)
ADF&G, 1973
Lensink and Bartonek, 1976

Seasonal habitat and trophic relationships among marine birds in lower Cook Inlet (Tables 6 and 7) have been documented by Sanger (written commun.). These data underscore the significance of bird interactions with marine pelagic and benthic communities.

Table 6. "KEY" MARINE BIRDS OF LOWER COOK INLET*

Species	Occurrence by Season and Habitat					
	Intertidal		Inshore		Offshore	
	F-W	S-S	F-W	S-S	F-W	S-S
Sooty Shearwater, *Puffinus griseus*						X
Short-tailed Shearwater, *P. tenuirostris*					X	X
Fork-tailed Petrel, *Oceanodroma furcata*			X			X
Cormorants, *Phalacrocorax* spp.			X	X		
Canada Goose, *Branta canadensis*		X				
Snow Goose, *Chen carulescens*		X				
Mallard, *Anas platyrhynchos*			X	X		
Pintail, *A. acuta*				X		
Greater Scaup, *Aythya marila*				X		
Common Goldeneye, *Bucephala clangula*			X			
Barrow's Goldeneye, *B. islandica*			X			
Oldsquaw, *Clangula hyemalis*			X			
Harlequin Duck, *Histrionicus histrionicus*			X			
Common Eider, *Somateria mollissima*				X		
White-winged Scoter, *Melanitta deglandi*			X	X	X	X
Surf Scoter, *M. perspicillata*				X		
Black Scoter, *M. nigra*			X	X		
Sandhill Crane, *Grus canadensis*		X				
Bald Eagle, *Haliaeetus leucocephalus*		X				
Whimbrel, *Numenius phaeopus*		X				
Rock Sandpiper, *Calidris ptilocnemis*	X					
Least Sandpiper, *C. minutilla*		X				
Dunlin, *C. alpina*	X	X				
Western Sandpiper, *C. mauri*	X	X				
Northern Phalarope, *Lobipes lobatus*		X		X		
Glaucous-winged Gull, *Larus glaucescens*		X		X		X
Mew Gull, *L. canus*	X		X		X	
Black-legged Kittiwake, *Rissa tridactyla*			X	X	X	
Common Murre, *Uria aalge*					X	X
Pigeon Guillemot, *Cepphus columba*			X	X		
Marbled Murrelet, *Brachyramphus marmoratus*			X	X	X	
Kittlitz's Murrelet, *B. brevirostris*			X	X		
Tufted Puffin, *Lunda cirrata*						XX

*Compiled with the assistance of David Erikson, Paul Arneson and Colleen Handel.
F-W=Fall-Winter; S-S=Spring-Summer

Table 7. KNOWN FOOD WEB LINKS FOR BIRDS FROM LOWER COOK INLET AND ELSEWHERE IN THE GULF OF ALASKA

SOOTY SHEARWATER	
Fish	Mallotus villosus,[1] 10-14 cm Ammodytes
SHORT-TAILED SHEARWATER	
Fish	Mallotus villosus,[2] 6-8 cm
Crustaceans (Euphausiids)	Thysanoessa inermis, T. raschii,[3] 1.5-3 cm
CORMORANTS	
Fish	Ammodytes Cottidae, up to 12 cm
Crustaceans (Shrimp)	Pandalus danae, 7-8 cm
OLDSQUAW	
Clams	Macoma baltica
SCOTER SPP	
Fish	Ammodytes Clupea roe
Clams	Mytilis Nuculina, ca. 1 cm Macoma baltica
DUNLIN[4] and WESTERN SANDPIPER[4]	
Clams	Macoma baltica, 3 mm Mya sp, 3 mm Mytilis, 3 mm
Crustaceans (Gammaridea)	Corophium salmonis
GLAUCOUS-WINGED GULL	
Fish	Ammodytes
BLACK-LEGGED KITTIWAKE	
Fish	Ammodytes
COMMON MURRE	
Fish	Mallotus villosus, 13-14 cm Ammodytes
Crustaceans (Shrimp)	Pandalis dispar, 2 cm P. danae, 7-8 cm

PIGEON GUILLEMOT		
	Fish	Blennies (summer) Small cottids (summer)
	Crustaceans (Shrimp)	*Pandalus dispar*, 2 cm (winter)
MARBLED MURRELET		
	Fish	Blennies (summer) Small cottids (summer) *Ammodytes*[5], up to 9 cm *Cymatogaster aggregata*[5], up to 6 cm
	Crustacea (Euphausiids)	*Thysanoessa* spp (*inermis*, *raschii*, *spinifera*), up to 3 cm (winter)
KITTZLITZ'S MURRELET		
	Crustacea (Euphausiids)	*Thysanoessa* spp (winter)
TUFTED PUFFIN[6]		
	Fish	Osmeridae, 6-14 cm (summer)

Footnotes

[1] Western Kodiak Is. area, USFWS, unpubl.

[2] Barren Is. area, USFWS, unpubl.

[3] Northeastern Gulf of Alaska, USFWS, unpubl.

[4] Copper River delta, Stan Senner, unpubl.

[5] Dixon Entrance (Sealy(1975), Can J Zool, 53(4):418-433).

[6] Barren Is, David Manuwal, unpubl.

Infrastructure, Economic Base and Human Uses

The early phases of oil and gas exploitation, specifically, the prediscovery period, require locating and operating one to several support/service bases. The ability of a given location to provide the facilities and services (infrastructure) necessary to support onshore industrial buildup in response to offshore development is an important consideration in any large facility siting decision. Historically, industry has focused on communities to provide needed services during this phase (Baldwin and Baldwin, 1974). Roads, airports, schools, housing, public utilities, and harbor facilities are some of the infrastructural requirements that make coastal communities attractive to developers. Environmental, cultural, and economic impacts resulting from accelerated development activities are often extreme and often adverse if not accompanied by responsive planning. Increased demand for public utilities and services, cost of living increases, economic dislocations, and intensified coastal development are examples of effects resulting from rapidly growing community-based industrial activity. Commercial and residential buildup often proceeds in excess of the rate of sewage treatment facility construction, solid waste disposal site upgrading, and community land use planning efforts. Competition between industry and community for the public water supply and electrical power represent additional concerns.

Environmental impacts of a short-term nature, such as improper disposal of liquid and solid wastes and stress on housing facilities, and the more permanent stamp of habitat destruction and histily decided land use allocations invariably result from rapid buildup. These kinds of social and environmental impacts are minimized where there is existing, well-developed infrastructure and/or where community planning efforts can provide needed services in a timely manner.

Large communities characteristically have a more well-developed infrastructure than small ones and consequently are more able to accommodate a rapid influx of population; a diverse, year-round economic base, recreational opportunities, housing facilities, and advanced utility systems are primary reasons. This overview section of the <u>Environmental Assessment of Lower Cook Inlet</u> provides a backdrop of community services, utilities, and economic bases for added perspective on the infrastructure-community impact issue.

Phase two of oil and gas exploitation, development and production, must consider oil terminal, LNG plant, and production treatment plant facility siting. Such facilities do not necessarily require sites in or near communities. Their location may be dictated primarily by proximity to producing fields (U.S. Dept. Interior, 1976), as well as the presence or absence of an adequate harbor and shoreline acreage. The analysis here recognizes this possibility and is extended to nonpopulated coastal areas that are potentially acceptable development sites.

The Cook Inlet Region, which includes the Anchorage, Kenai Peninsula, Cook Inlet, Palmer, Wasilla, Talkeetna, and Seward areas, contained 53.8% of the total labor force in the state during 1974. Eighty-eight percent of this labor force was in the Anchorage area. Of the remaining labor force in Cook Inlet, 7.9% was located in the lower Cook Inlet study area, representing 7.4% of the region's nonagricultural wages (U.S. Dept. Interior, 1976).

Unemployment in Kenai-Cook Inlet is high, averaging 15.7% in 1974. Seasonal variation in employment is also high. Income fluctuates seasonally primarily due to variations in the fishing, tourism, and construction industries (U.S. Dept. Interior, 1976).

Table 8 provides a breakdown by employment category for the Cook Inlet Basin. Government is the major employer in the region. Although much of this employment is centered in Anchorage, government is also the primary employer in the Kenai-Cook Inlet area (21% of the work force). Since 1961, oil and gas have strongly influenced the economy in the Kenai-Northern Cook Inlet area. Table 9 provides an estimate of direct employment generated by the hydrocarbon industry in this area. Oil and pipeline companies are the 10 largest taxpayers in the Kenai Peninsula Borough; their assets comprised 49% of the Borough's assessed evaluation in 1975 (U.S. Department of the Interior, 1976).

Fisheries, tourism, and recreation represent the major economic mainstays south of Kenai. However, contract construction and mining can also be expected to become major influences on the ecomony of this area as development of lower Cook Inlet oil and gas resources evolves during the next decade (U.S. Army Corps Engineers, 1974b).

Table 8. LABOR FORCE SUMMARY COOK INLET BASIN 1970-1974*

	1970 Average Annual	1971 Average Annual	1972 Average Annual	1973 Average Annual	1974 Average Annual	% Change 1970-1974	% of State-Wide Average Annual 1970	% of State-Wide Average Annual 1974
Civilian Resident Labor Force**								
Total Labor Force	57,193	62,480	66,614	69,483	80,082	40.0	52.9	53.8
Total Unemployment	4,646	5,990	6,783	7,618	7,946	71.0	47.9	53.3
Percent of Labor Force	8.12	9.59	10.18	10.91	9.92	-	-	-
Total Employment	52,547	56,490	59,831	62,225	72,136	37.3	53.3	53.8
Nonagricultural Wage and Salary Employment***								
Mining	1,610	1,441	1,334	1,328	1,539	-4.4	53.7	51.3
Contract Construction	3,988	4,463	4,804	4,619	6,458	61.9	57.8	45.8
Manufacturing	1,569	1,747	1,768	1,915	2,095	33.5	20.1	19.9
Transp-Comm. & Public Util	4,314	4,969	4,921	5,095	6,168	43.0	47.4	49.7
Trade	9,402	10,127	10,805	11,540	13,298	41.4	61.1	63.0
Finance-Ins. & Real Estate	2,002	2,115	2,529	2,927	3,293	64.5	64.6	67.2
Services	7,049	7,677	8,516	9,287	11,216	59.1	61.8	61.3
Miscellaneous	52	114	130	172	201	286.5	5.8	20.1
Government	17,071	18,193	19,213	20,014	21,235	24.4	48.0	48.5
Federal	9,776	9,793	9,672	9,777	10,158	3.9	57.2	56.4
State & Local	7,295	8,400	9,541	10,237	11,077	51.8	39.6	42.9

Source: Alaska Department of Labor, Alaska Labor Force Estimates by Industry and Area, 1970-1974 In: USDI, Alaska OCS Office, Lower Cook Inlet Draft Environmental Impact Statement, Vol. I, 1976

* The Cook Inlet Basin includes Anchorage, Palmer-Wasilla-Talkeetna, Kenai-Cook, and Seward Larbor Areas.

** Civilian Resident Labor Force shows total civilian labor force, the two components of labor force, total employment and unemployment, and the unemployment rate. The unemployment rate is the percentage of the civilian labor force that is unemployed. The total employment figures include self-employed persons, unpaid family workers, domestics, agricultural workers, and workers directly involved in work stoppages, as well as nonfarm wage and salary employment adjusted for multiple job holding and commuting. The contents of this table are on a place of residence basis.

*** Nonagricultural Wage and Salary Employment is by place of establishment subdivided into major industry divisions. Employment estimates for industry divisions are withheld to comply with disclosure regulations in some labor areas.

Mineral resources other than oil and gas represent significant potential for development in the lower Cook Inlet region. Significant deposits of diatomaceous earth occur near Kenai (Kenai Comprehensive Plan, 1965), while some development of limestone deposits occur near Seldovia. Coal is found underlying much of the study area from Homer to Nikiski. A portion of the vast Beluga coalfield extends along the west coast of lower Cook Inlet from the Forelands to south of Harriet Point (Alaska Department of Natural Resources, 1975). Large low-grade chromite deposits are readily accessible near the southwest tip of the Kenai Peninsula (U.S. Army Corps Engineers, 1974b), and extensive reserves of iron titanium, copper, gold, molybdenium, lead, zinc, and pumice are suspected between Iliamna Lake and Kamishak Bay (U.S. Army Corps Engineers, 1974b; Selkregg et al., 1973). These deposits are attractive due to their proximity to coal, oil, and natural gas, as well as ice-free portions of Cook Inlet (U.S. Army Corps Engineers, 1974b). Gravel and aggregate is borrowed for construction. On the east coast of lower Cook Inlet north of Kachemak Bay, most gravel borrows are on the uplands close to the construction site because of the ready availability of unconsolidated sands and gravel in the Quarternary glacial deposits of the Kenai Peninsula. In many areas south of Kachemak Bay, gravel sources are restricted to outwash and flood plains, river deltas, and tidal wetlands.

Logging and timber processing is conducted on a small scale. The lack of roads in the primary logging areas south of Kachemak Bay necessitates marine transportation of logs and finished products. The production and shipment of cants is an intensive activity at Jakolof Bay north of Seldovia.

Although fishing and fish processing industries of Cook Inlet are secondary to the petroleum industry in annual dollar value of production, they represent a major labor force and economic base in lower Cook Inlet. Of the nearly 14 million dollars realized from commercial fisheries in Cook Inlet during 1974, over 80% was from this area (U.S. Dept. Interior, 1976). In addition, fisheries resources are renewable and, if managed properly, can provide the region indefinitely with a stable and valuable industry. In this context, a comparison of values for 1970--$5 million for fisheries vs $240 million for petroleum--takes on a different meaning (U.S. Army Corps Engineers, 1974b).

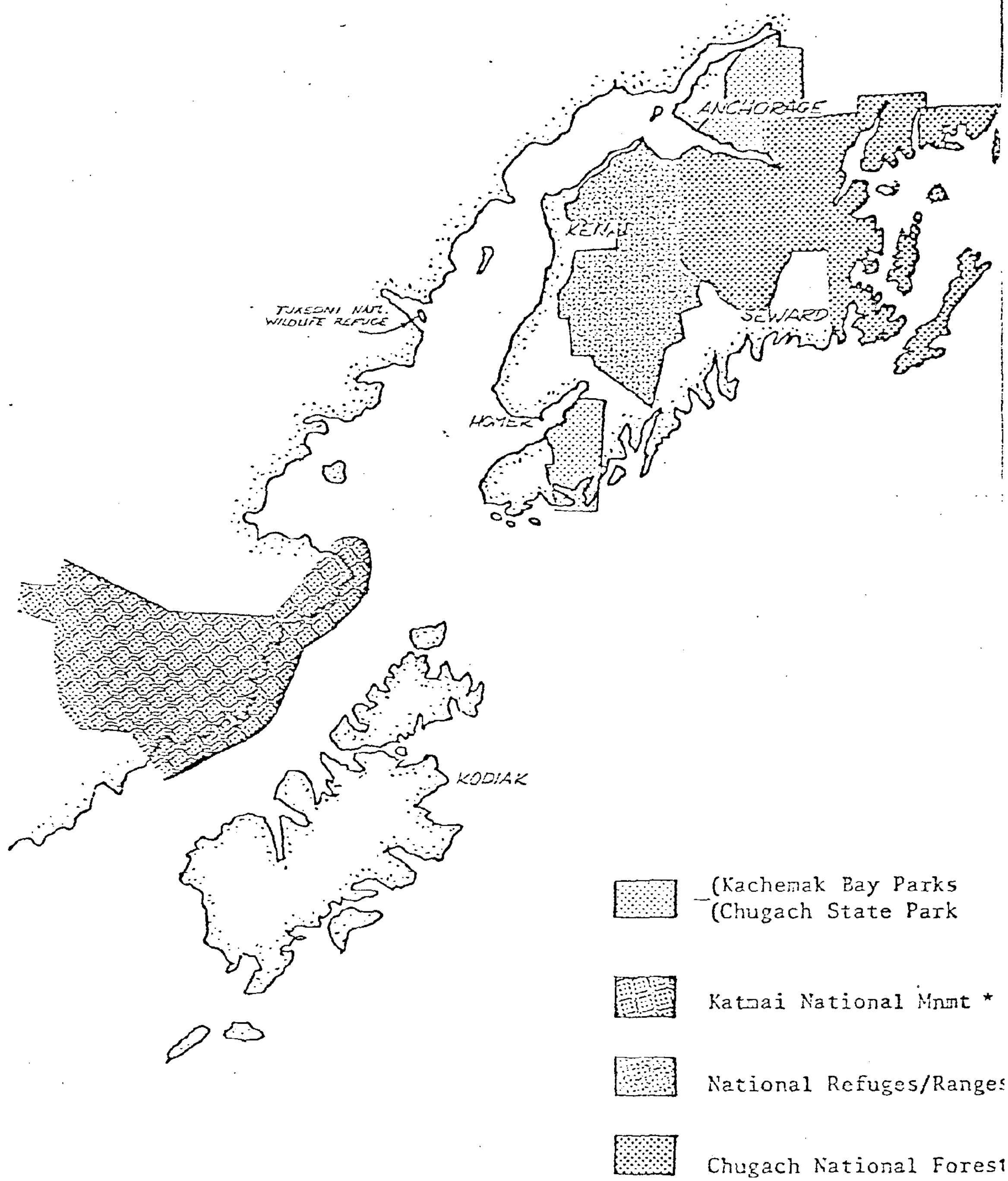
Razor clams are taken primarily along the east coast of Cook Inlet from Nikiski to Anchor Point. The three commercial fishing districts designated by the Alaska Department of Fish and Game for lower Cook Inlet provide an abundance of shrimp, crab, salmon, clams, herring, and halibut. Kachemak Bay accounts for 62% of the total Cook Inlet shellfish harvest (U.S. Dept. Interior, 1976). Salmon support an important fishery in all districts.

Sport fisheries also contribute significantly to local economics. A major sport fishery for chinook salmon now exists off the mouth of Deep Creek, contributing to Ninilchik's economy, and steelhead runs in the Anchor River, Deep Creek, Ninilchik River, and Stariski Creek provide the basis for an important sport fishery (U.S. Army Corps Engineers, 1974b).

With Alaska's growing population and the increasing number of out-of-state visitors, more travelers are enjoying sports and recreation throughout the state. To Alaskan communities, this means a boost to local economy. It also means the State and the communities must spend additional efforts to develop methods and facilities to accommodate the seasonal influx of nonresidents.

Tourism and recreation sustain an important industry in Cook Inlet. Figure 14 shows the major recreation and management units in the Cook Inlet area. Table 10 gives a quantitative picture of Alaska's wildlife resources and some projections as to their future supply and demand. This report centers on the eastern side of Cook Inlet, because it is along this shore that most of the concentrated development is occurring. A major task for planners is to guide the course of local massive industrial development in a manner compatible with recreational needs and the natural environment.

Recreational boating occurs mostly in the lower inlet. Beachcombing, clamming and fishing are also popular activities there. These recreational opportunities are not generally available in the upper inlet because of the turbidity of the water and relatively unproductive and unaesthetic beaches (U.S. Army Corps Engineers, 1974b). Boating is particularly popular in Kachemak Bay. A significant trailer and boat migration occurs from Anchorage to the lower inlet during the summer season.



* Boundary extends offshore by proclamation. Water is owned by State of Alaska.

Fig. 14. RECOGNIZED RECREATION OR MANAGEMENT UNIT ON COOK INLET

Source: U. S. Corps of Engineers, 1972. The Cook Inlet Environment, A Background Study of Available Knowledge, U. S. Corps of Engineers, Alaska District, Anchorage, Alaska P. V-1

Table 10

ALASKA NATIONAL FORESTS - WILDLIFE RESOURCE

ESTIMATED 1/ PRESENT AND FUTURE SUPPLY AND DEMAND

	1962			1976			2000		
Species or Group	Total Supply #	Usable Surplus #	Harvest Demand # 2/	Total Supply #	Usable Surplus #	Harvest Demand # 2/	Total Supply #	Usable Surplus #	Harvest Demand # 2/
Big Game:									
Sitka Deer	200,000	50,000	13,000	210,000	52,000	25,000	220,000	55,000	40,000
Moose	4,000	1,000	500	4,000	1,000	950	4,000	1,000	1,600
Roosevelt Elk	1,200	300	120	1,400	350	200	1,800	450	400
Mountain Goat	12,700	3,000	400	12,700	3,000	800	12,700	3,000	1,500
Dall Sheep	900	200	15	900	200	50	900	200	100
Black Bear	5,800	1,160	200	6,000	1,200	400	6,000	1,200	700
Glacier Bear	300	60	5	300	60	20	300	60	40
Brown Bear	6,900	690	150	6,700	670	300	6,500	650	500
Timber Wolves	2,000	500	80	1,900	475	160	1,800	450	250
Wolverine	1,000	250	20	900	180	40	800	160	70
Waterfowl 3/	Not possible to assess	Exceeds demand	40,000	Same numbers as 1962	Will exceed demand	80,000	Possible reduction	Not possible to access	150,000
Salmon (comml. & sport uses) 4/	---	26MM	26MM	---	48MM	48MM	---	57MM	57MM
Trout, Char & Grayling	Not possible to access	Exceeds demand; local shortages	Less than surplus	Same numbers as 1962	Exceeds demand local shortages	Less than surplus	Same numbers as 1962	Exceeds demand; local shortages	Less than surplus
Furbearers	Abundant	Not known	Less than surplus	Abundant	Not known	Less than surplus	Abundant	Not known	Less than surplus
Grouse & Ptarmigan	---	---	Less than surplus	---	---	Less than surplus	---	---	Less than surplus

Source: U. S. Forest Service, Alaska Region, 1974. Draft Environmental Impact Statement, Land Use Plan, Chugach National Forest p. 400 - J-I

Other recreational activities on the lower inlet include hiking, sightseeing, and camping. The Department of Natural Resources, Alaska Division of Parks, maintains four wayside campground facilities on the Kenai Peninsula bordering lower Cook Inlet. Commercial accommodations are available at Ninilchik, Kenai, Anchor Point, Homer, and Seldovia. These are used extensively by tourists in the summer season, and by hunters and fishermen throughout the year. Clam Gulch is one of the most heavily used weekend and summer vacation spots on the Kenai Peninsula. State Park developments along the lower inlet coast have been proposed to meet rapidly growing recreational needs. The 1973 recreational use of the Kenai Peninsula was estimated to be 2.1 million recreation days. Use is expected to increase in proportion the region's growth, particularly around the Anchorage area (Alaska Department of Natural Resources, 1975).

Overall accessibility and community attitudes towards tourism seem to be key factors in projecting future tourist activity in a particular area. Although Seldovia, English Bay, and Port Graham have tremendous potential as scenic attractions, the lack of adequate harbor facilities, roads, and accommodations will probably preclude rapid expansion of the tourist industry at this time.

The peak season for tourism overlaps that of the fishing industry, and will either conflict with the industry's manpower and facility needs or result in more development and influx of people to handle the tourists. Often small communities do not have enough off-season employment to take up the winter slack in economic activity; thus a large volume of visitors will perpetuate a seasonal employment cycle, and the winter slump will be even more pronounced. Without considerable development of facilities and services to accommodate tourists, existing housing and services could be greatly strained.

The pattern of development which evolves in each area will largely determine not only the volume but the type of tourists who will be attracted to a particular location. Hunters and fishermen arrive with different expectations than travelers looking for scenery and entertainment, so these groups require different services and accommodations. Their timing depends on the management practices with regard to various natural resources; impairment of an area's visual quality will lose sightseers, and depletion, fluctuation, or restriction of fishing and hunting stocks will affect the number of sportsmen visiting the area.

Communities on the Kenai Peninsula which are connected by paved roads and are within easy driving distance from the Anchorage area can expect a greater number of visitors. Short trips and outings lasting one to two days are the most popular form of travel among Alaskans in this region (Alaska State Housing Authority, 1968). The peninsula is therefore an attractive destination.

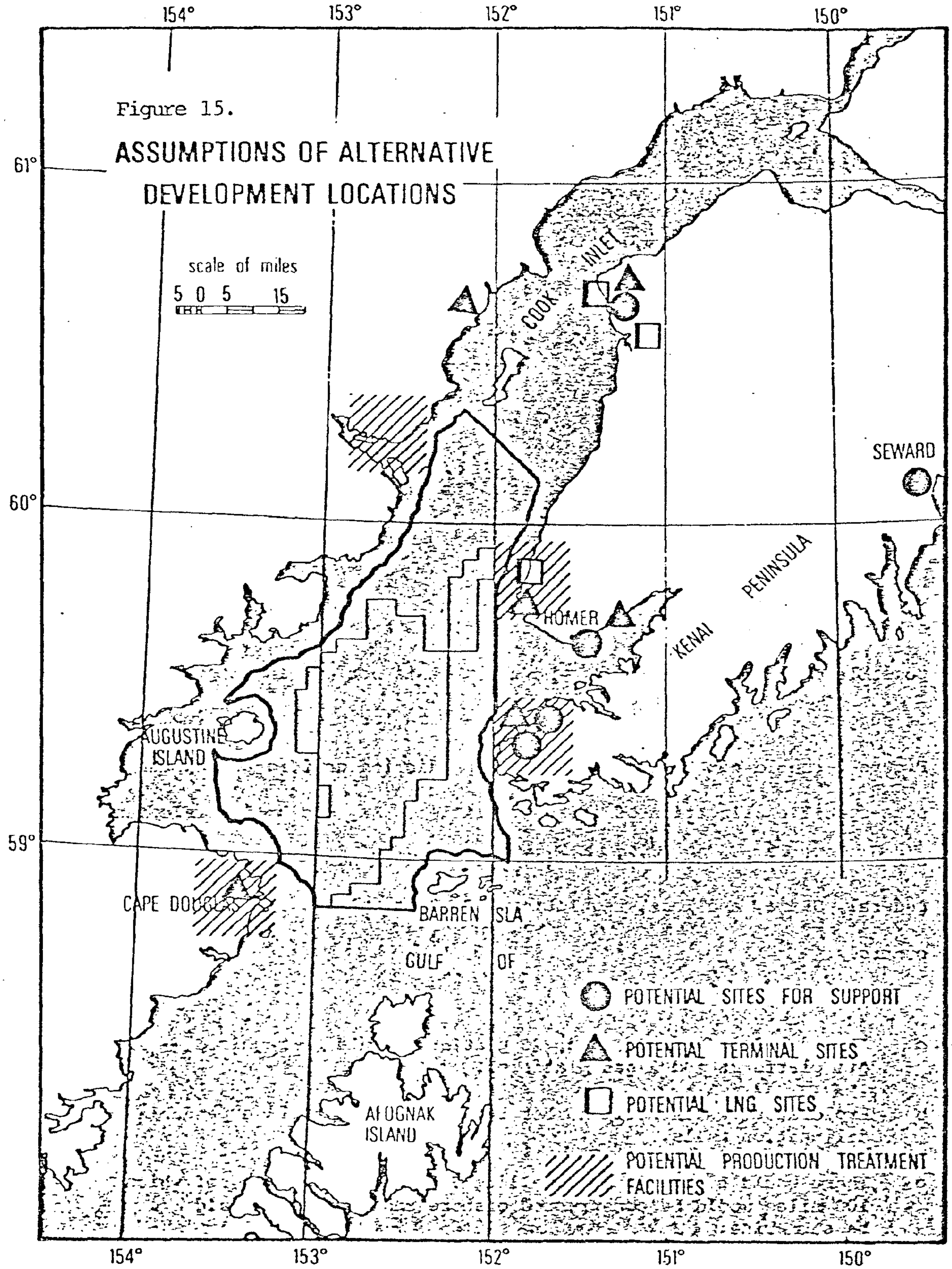
Nonresident traffic is also increasing throughout the state. It is essential that extensive planning go into the design of campgrounds, sewage and parking facilities, and food and housing accommodations. With proper foresight and development in keeping with a community's long range goals, maintenance of each area's natural attractions and increased human usage should prove to be mutually complementary and sustainable objectives.

COASTAL ENVIRONMENT AND INFRASTRUCTURE OF POTENTIAL DEVELOPMENT LOCATIONS

Several coastal areas in Cook Inlet have received a high level of interest by industry as potential development locations. Both coastal communities and several nonpopulated areas have been proposed as alternative development sites (Fig. 15). Categories of onshore facilities include supply/service bases, liquified natural gas (LNG) plants, oil terminals and production treatment facilities.

The following are some assumptions regarding facility siting taken from Vol. I, page 15, lower Cook Inlet DEIS (U.S. Dept. Interior, 1976):

> The location of support and supply facilities, crude oil terminal sites, and onshore production treatment facilities could depend mainly upon the location of producing fields in relation to the physical environment. Potential support and supply facilities would likely be located at Homer, Kenai, the Seldovia-Port Graham area, and Seward. The Kodiak area was considered as a possible support and supply region. However, greater distances from this area to the lower Cook Inlet and weather severity in the Shelikof and Kennedy straits areas suggest that Kodiak is not a viable alternative. Potential onshore crude oil terminal and treatment sites are the Seldovia-English Bay-Port Graham area and the Cape Douglas area for any discoveries in the southern part of the sale area and for discoveries in the northern part of the sale area, the Anchor Point area and the west side of the inlet might be used. The present terminal and storage facilities at Nikiski and Drift River might also be used for production from oil and gas fields in the northern part of the sale area. For the pusposes of this DEIS, two new onshore terminals, and two production treatment facilities (may or may not be with terminals) are assumed with all other production going to existing facilities.
>
> No petroleum refineries are expected to be constructed in Alaska as a result of the sale.
>
> No manufacturing of platforms is anticipated to occur in Alaska.
>
> The natural gas would be marketed, and there would be one liquified natural gas (LNG) plant constructed around 1984.



Source: USDI, Alaska OCS Office, Lower Cook Inlet Draft Environmental Impact Statement, Vol. I, 1976

The support and supply fleet required to service the offshore rigs during the exploratory phase would be 3-18 boats and approximately 21 boats during the peak development phase.

The regional environmental analysis of the previous section provides a broad perspective on the resources, physical processes, and infrastructure of Cook Inlet. The following analysis emphasizes site-specific environmental values, human uses and infrastructure. The analysis is divided into two sections: (1) Coastal communities, and (2) Nonpopulated areas.

The first section addresses Kenai-Nikiski, Ninilchik, Anchor Point, Homer, Seldovia, Port Graham, and English Bay as plausible sites for one or more industrial facilities. The second section discusses coastal areas outside populated regions that qualify as potential industrial facility siting locations due to protected deep harbors and acreage available to construct shore facilities.

The environmental analysis for each of these alternative development locations integrates information on community infrastructure, fish and wildlife resources, primary producers and consumers, wetlands and coastal hazards, and other natural constraints to provide a comprehensive approach to describing the location. A matrix of biological resources is provided (Table 11) to facilitate comparisons of relative enviornmental values of the proposed development locations. This analysis serves as a useful guide in the future determination of permissible land and water uses and priorities of uses within the regions discussed. It provides information for use in reviewing permit applications for coastal development activities attendant to OCS buildup and other projects.

Table 11. Aquatic and terrestrial fish and wildlife resources of potential development locations on Cook Inlet.

RESOURCE VALUE	PROPOSED DEVELOPMENT LOCATIONS										
	Nikiski	Kenai	Cape Starichkof†	Anchor Point	Homer	Seldovia	English Bay Port Graham	Cape Douglas	Tuxedni Bay	Drift River	Trading Bay
WILDLIFE											
Moose, concentrated areas	✓	✓	✓	✓	✓						✓
Brown bear: fish streams			✓	✓	✓						✓
Brown bear: intensive spring use								✓	✓	✓	
Black bear: present		✓	✓	✓	✓	✓				✓	
Black bear: intensive spring use									✓		✓
Waterfowl & Seabirds: nesting/molting	✓	✓	✓	✓					✓	✓	✓
Waterfowl & Seabirds: wintering			✓	✓	✓	✓	✓	✓			
Seabird colonies					✓	✓			✓		
Caribou: winter range		✓									
Caribou: calving grounds		✓									
Caribou: migration route		✓									
Harbor seal: present	✓	✓	✓	✓	✓	✓	✓			✓	✓
Harbor seal: high density								✓	✓		
Sea otter: present				✓	✓	✓	✓	✓			
Sea otter: high density											
Sea lion rookeries							✓				
Whales	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
FISHERIES											
[illegible] and chum salmon: spawning drainage		✓	✓	✓	✓✓	✓✓	✓	✓✓	✓✓	✓	✓
Chinook salmon: present		✓	✓	✓							
Sockeye salmon: present		✓								✓	✓
Coho salmon: present		✓	✓	✓		✓			✓	✓	✓
King crab: commer. fish.					✓	✓	✓	✓			
Tanner crab: present			✓	✓	✓	✓	✓	✓			
Dungeness crab: comm. fish.			✓	✓	✓						
Shrimp: commercial fish.					✓	✓	✓				
Halibut: commer. fish			✓	✓	✓	✓	✓	✓	✓		
Halibut: present											✓
Areas of larval & juvenile crustacean concentration			✓	✓	✓	✓	✓	✓	✓		
Kelp beds			✓	✓	✓	✓	✓	✓			
Herring: present			✓	✓	✓			✓			✓

†Information on Cape Starichkof may be applied to Ninilchik.

COASTAL COMMUNITIES

Kenai/Nikiski

The 1974 population estimate for the Kenai area was 4,028 (Alaska Dept. Environmental Conservation, 1975). The petroleum industry is the major employer; construction, fishing, tourism, and trade also contribute to the economy.

Kenai and surrounding areas are connected to the Sterling Highway. In addition, 33.3 miles of local roads and 114 miles of State roads were maintained in 1975. A 7,500 foot long asphalt-surfaced airfield serves the community. Daily service is provided by Alaska Aeronautical Inc. to Anchorage and Homer. Seven locally-based nonscheduled air carriers also operate out of the area. Northland Marine and Foss Alaska are the primary waterborne carriers. Marine facilities available in the Kenai River area are summarized in Table 12 and Figures 16 to 18. Two canneries operate on the Kenai River Flats. Open moorage on the river and dry storage are typical means of vessel storage.

Domestic water is provided by city wells and a North Kenai well (Galliett, 1976). Both these water well sources are depletable or otherwise deficient in that they can only be expected to supply future domestic water needs for 2-5 years at the projected level of growth (Table 13). Industrial water supply for the petroleum complex at Nikiski is likewise deficient and must be increased significantly (up to 3,000 GPM) to meet the needs of proposed expansion. The availability of water is a primary problem on the Kenai Peninsula.

Table 12. Port and Harbor Facilities Summary, Kenai

Community: Kenai *Region:* Southcentral

Latitude: 60° 40' *Longitude:* 151° 20'

Waterway Locations: Cook Inlet ; Kenai River

;

Number of Facilities in Inventory: 12

Breakwaters: *No* ___ *Yes* X *Number* 1

Docks: *No* ___ *Yes* X *Number* 9

SB Harbors: *No* X *Yes* ___ *Number* ___

Canneries: *No* ___ *Yes* X *Number* 2

Floats: *No* ___ *Yes* X *Number* 2

Piers: *No* ___ *Yes* X *Number* 5

Freight Terminals: *No* ___ *Yes* X *Number* 4

Transshipment Points: *No* ___ *Yes* X *Number* 8

Passenger Terminals: *No* ___ *Yes* X *Number* 3

Boat Repair Grids: *No* ___ *Yes* X *Number* 2

Boat Launch: *No* ___ *Yes* X *Number* 4

Services Available:

- *Fueling:* *No* ___ *Yes* X
- *Boat Repair Yards:* *No* ___ *Yes* ___
- *Marinas:* *No* ___ *Yes* ___
- *Customs:* *Complete* ___ *Limited* ___ *Request* X

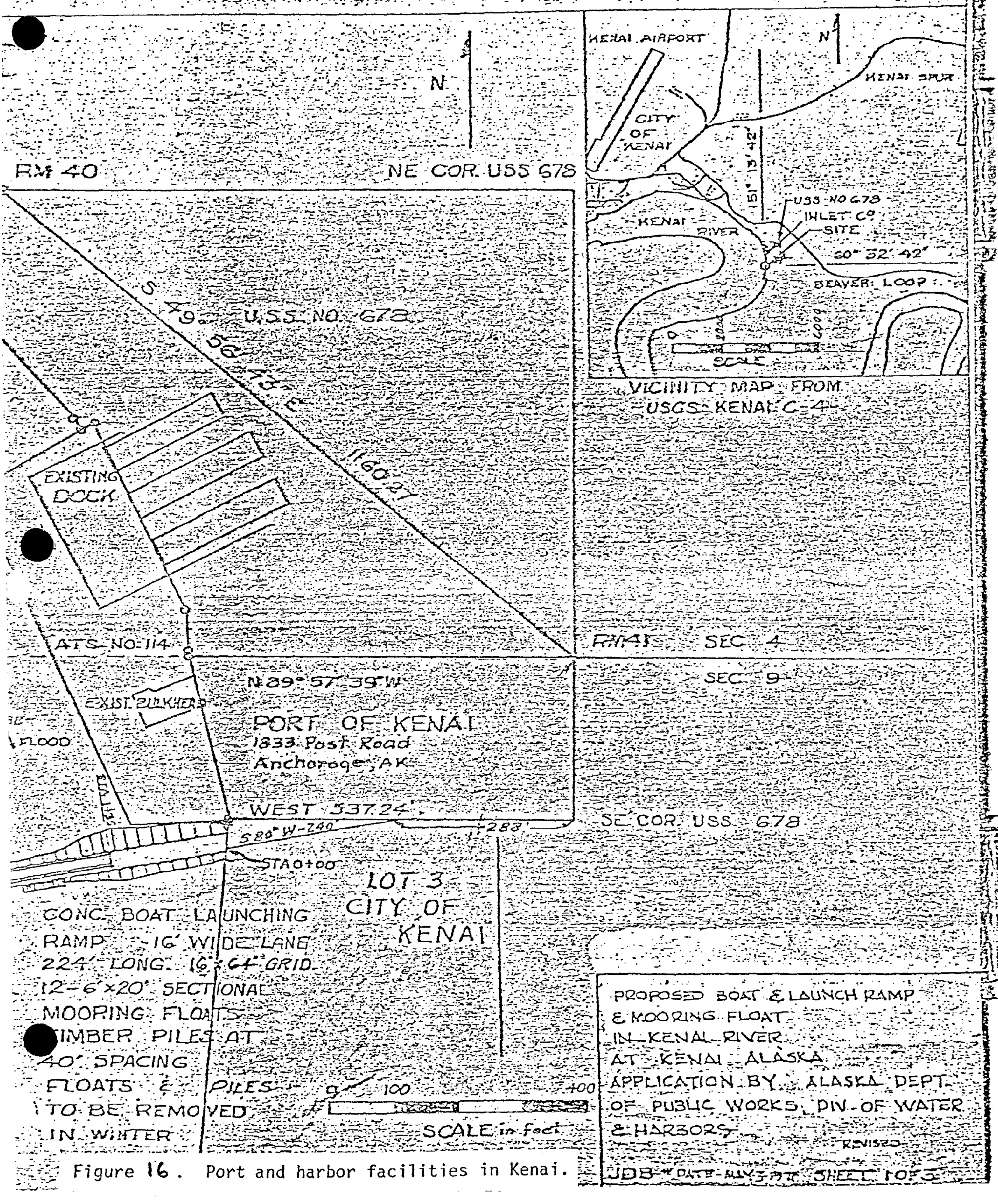


Figure 16. Port and harbor facilities in Kenai.

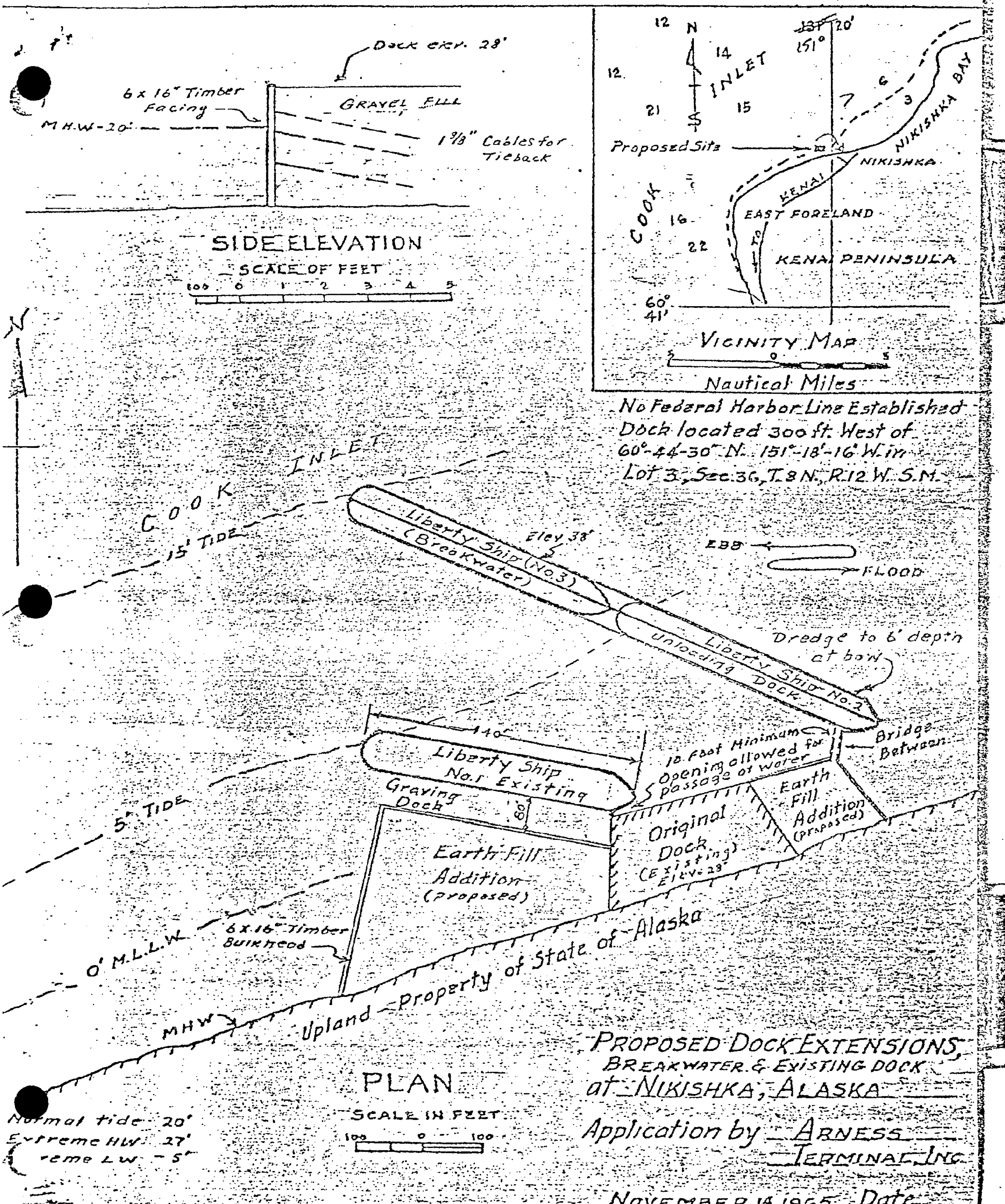


Figure 17 . Dock facility of Arness Terminal, Inc. at Nikishka.

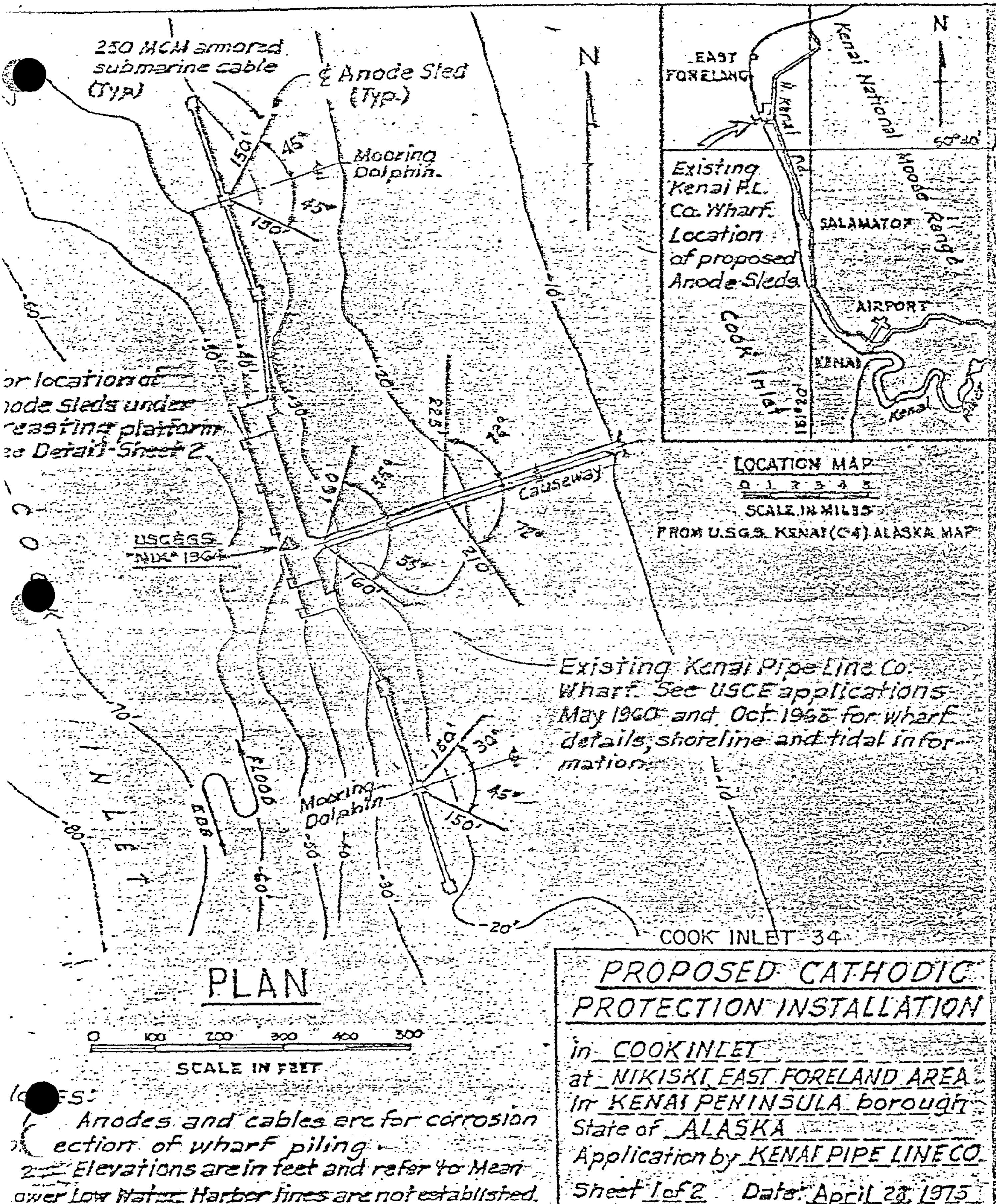


Figure 18. Docking facility of Kenai Pipeline Co. at Nikiski.

Table 13

KENAI-NORTH KENAI WATER NEEDS ESTIMATE AS OF JANUARY 2, 1976

Consumer	Present Need GPM	Present Supply GPM	** Future Need GPM	** Future Supply GPM
Collier (Chemical	800	(1,200)*	1,800	1,800
Phillips (LNG)	200	(400)*	200	(400)*
Other (Refineries, etc.)	200	(400)*	400	(400)*
Pacific Alaska (LNG)			200	200
DOMESTIC				
Kenai	500	(800)*	800	800
North Kenai	100	(200)*	200	200
TOTAL	1,800	(3,000)*	3,400	(800)* 3,000

Standby Well Supply		
City Well No. 1 = (800)*		
Collier Well = (1,200)*		- (2,000)*
Allowance For (1) Peak Demand		
(2) Fire		
(3) Growth		- (2,000)*
(4) Breakdowns		
(5) Maintenance		
New Artesian Supply Needed		3,000
		-0-

*Depletable or otherwise deficient well water sources
**2-5 Years hence

Galliet, Harold H., Jr. 1976. Engineers preliminary esitmate, water rates, industrial waterline. City of Kenai, Kenai, Alaska. 7 p.

Electricity is supplied by 6,200 KW capacity diesel-powered generators. Sewage receives secondary treatment at the Wildwood Station in Kenai. The Peninsula Sanitation Company operates a permitted sanitary landfill (Fig. 19) with Dempster dumpster and compaction capabilities. Waste oil and sludge from sewage are also disposed of at the site. The landfill has some cover and is in fair condition (Alaska Dept. Environmental Conservation, 1976). Some problems exist with wind and winter collection and disposal; odors are often generated in winter when compaction is difficult (Alaska Dept. Health and Social Services, 1975). A secondary transfer site is located in North Kenai (Salamotof) and garbage is hauled to Kenai (Fig. 19).

The Kenai Borough operates four elementary schools, a junior high school, and a high school. The Kenai Community College is an extension of the University of Alaska with an enrollment of 529 in 1975.

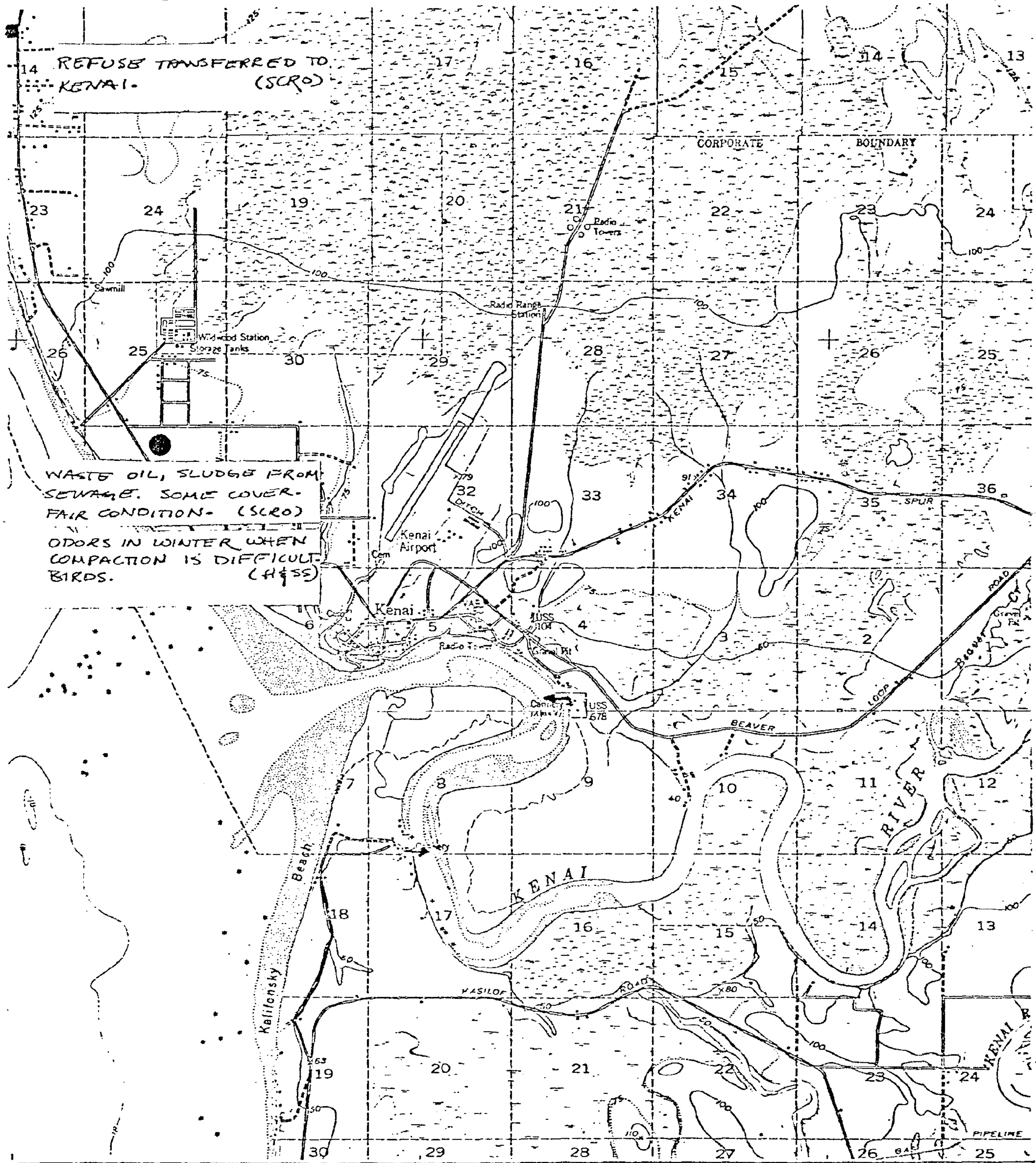
Total housing units censused in 1970 numbered 1,176 including 231 mobile homes and 204 vacancies. Numerous hotel/motel complexes are available for transients, with approximately 100-150 rooms, and there is an 11-space public campground.

Kenai offers both scenic and historic attractions to the visitor. It can expect a continuing growth in tourism as the growing Anchorage population turns increasingly to this easily accessible recreation area (Alaska State Housing Authority, 1968). There are a number of buildings dating from the original Russian community which are being restored for their historic value. Outdoor activities include sightseeing, canoeing, hunting, clamming, fishing, and boating.

Figure 19 . WASTE DISPOSAL: Kenai, Alaska

Outfalls inventoried in region: 15
Dump sites inventoried in region: 2

USGS Quadrangle: Kenai (C-4) 1:63,360



KEY

→	Outfall, raw sewage	O	Modified landfill
■→	Outfall, treated sewage	▲	Open dump
→	Outfall, industrial sewage	+	Promiscuous dumping
●	Sanitary landfill	■	Transfer sites, incinerators, or recycling facilities

The Kenai/Nikiski region is the site of major urea, ammonia, and petroleum industries. Collier Carbon and Chemical Corporation and Phillips, Standard, and Tesoro oil companies all discharge pollutants to the atmosphere within a relatively concentrated area. The Phillips LNG plant discharges quantities of NO_x, SO_2, and some particulates. The Collier plant emits large quantities of particulates, some NO_x and SO_2 (20-30% of standard) and minute quantities of CO. Refineries emit low levels of NO_x, SO_2, and hydrocarbons. Particulates are commonly generated by road, airport, or housing construction as well as SO_2, NO_x, and CO from domestic fuel combustion. The standard for particulate matter has been violated at Nikiski several times since ambient air monitors were introduced (Hungerford, pers. commun.). There is considerable concern over the deterioration of air quality in the Kenai/Nikiski area, particularly with regard to the cumulative effect of particulate emissions from the six existing and several proposed facilities at Nikiski.

Seismic activity for Kenai and vicinity represents a high risk (Fig. C-1). The potential exists for severe ground shaking, local and regional uplift or subsidence, alterations of the groundwater hydrology, slope failure, tsunamis, and other phenomena induced by seismicity. During the 1964 earthquake, a large northeast-trending zone of extensive ground breakeage associated with unstable ground was observed within a few miles south and east of Kenai (Foster and Karlstrom, 1967).

Erosion is a problem along the north bank of the Kenai River as indicated on Fig. C-1. Here high waters combined with storms cause considerable activity (G.E. Pehrson, written communication). Severe erosion took place along the north bank during 1975. Erosion also takes place along the beach bluffs bordering Cook Inlet north and south of Kenai. This erosion was locally accelerated by subsidence associated with the 1964 earthquake (Stanley, 1967; U.S. Army Corps Engineers, 1974b).

Winds in the Kenai area prevail from the southwest during most of the year. During winter and spring, north-northeast winds prevail, and maximum wind velocities are from this direction (U.S. Dept. Commerce, NOAA Local Climatological Data, Annual Summary). Storm systems occurring almost every winter cause wind gusts of 50-75 knots at Kenai. Gusts frequently reach 75-100 knots over open water. In late summer and fall, strong southerly post-frontal winds occur as a result of the movement of storms west and north of the region (Federal Power Commission, 1976).

During the summer and fall, wind driven northerly littoral currents are generated. Under storm conditions this current augments the flood-tide current to produce a velocity of 5.4 ft/sec northward along the coast at nearby Ninilchik. North of Kenai at Nikiski, current velocities in excess of 14 ft/sec have been reported during similar conditions (U.S. Coast Guard in Federal Power Commission, 1976). These velocities are nearly double the normal flood velocities and, according to the Corps of Engineers (1974b), may be assumed responsible for much of the littoral transport of sediments, as illustrated in Figure C-1.

Frequency of flooding is rated as high for Kenai (U.S. Army Corps of Engineers, 1976). Flooding at Kenai is a phenomena primarily associated with the Kenai River. Twenty- and fifty-year flood levels could be caused by ice damming of the Kenai by the Skilak Glacier. Upon breakup of the ice, ponded waters would be released, resulting in flooding in the Kenai River valley (G.E. Pehrson, pers. commun.) Seasonal ice-jamming on the Kenai River has also been identified as a major cause of flooding (U.S. Army Corps Engineers, 1973a; 1976).

The extent of seasonal ice in Cook Inlet, indicated in Figures C-1 to C-6 can present a problem to navigation and shore installations, particularly during severe winters (U.S. Dept. Commerce, Coast and Geodetic Survey, 1964; U.S. Army Corps Engineers, 1974a; Federal Power Commission, 1976). Much of the problem is due to seasonal fluvial ice from upper Cook Inlet occurring in conjunction with tidal currents. When a wind-driven current reinforces the tidal current, velocities in excess of 8 knots are not unusual, and velocities approaching 11 knots have been reported. Huge cakes of ice, some a half of a mile wide, move up and down Cook Inlet at or near surface current velocities. Dangerous ice conditions threatening navigation and shore operations and facilities occur at nearby Nikiski, particularly when flood tides coincide with strong southwest winds (U.S. Coast Guard in Federal Power Commission, 1976).

Ice forms on the Kenai River from December to April and often jams during spring breakup (U.S. Coast Pilot, 1964; U.S. Army Corps Engineers, 1976b). During winter, the Kenai River remains in a semi-open state because of the tidal prism and the volume of river flow. However, shell and pan ice carried in and out by tides prevent small craft access to the river (U.S. Army Corps Engineers, 1974b).

The Kenai River delta has approximately 3.5 square miles of tidal wetlands that provide excellent waterfowl habitat. A few miles to the south, the Kasilof River delta includes about 2.0 square miles of wetland habitat (Fig.C-2). Waterfowl use of the Kenai Flats is secondary only to major flyways such as the Chickaloon Flats northeast of the Forelands. Waterfowl hunting on the wetlands is relatively extensive. Access onto the tidal wetlands is not well-developed, although a main arterial cuts across the flood plain to connect Kenai with the Kasilof Highway.

Marine productivity near Kenai is low compared to the lower inlet. Primary productivity is limited by the turbid waters characteristic of the upper inlet. Peak spring population abundances appear to be generally less than 0.5 million cells/liter, a low figure for a spring bloom (Schandelmeier, 1975).

Zooplankton populations documented for several years off Nikiski-North Kenai by the University of Alaska, Institute of Marine Science, were neither abundant or diverse during any season (Redburn, 1972). Copepods were the dominant group; barnacle, polychaete, and decapod larvae were of secondary importance from June through October. Intertidal production in the Nikiski-Kenai area is also very low. The sandy-gravel beach supports little apparent invertebrate or macrophytic standing stock. No attached or drift brown algae was observed in September at Nikiski or north of the Forelands (Alaska Dept. Environmental Conservation, 1976). Encrusting green algae and a few barnacles were observed on boulders in the high intertidal. The typical beach profile in the area is wave-beaten with large boulders from eroding cliffs in the high intertidal grading to gravelly sand and sandy-gravel in the mid to low intertidal. Subtidal macrophyte populations appear nonexistent. The intertidal zone north of the mouth of the Kenai River is sandy with rare drift specimens of Fucus and valves of Macoma apparent on the beach.

The North Kenai Peninsula provides habitat for muskrat, small furbearers such as lynx, mink, and snowshoe hares, coyote, spruce grouse, raptors, and nesting and molting waterfowl. Brown and black bears, wolverine, and moose are the primary large terrestrial mammals (Alaska Dept. Fish and Game, 1976). Harbor seals and beluga whales frequent upper Cook Inlet. Chinook, coho, pink, and sockeye salmon all spawn in the Kenai River drainage. Sonar facilities and a fish wheel to monitor adult escapement are maintained on the Kenai River by the Alaska Department of Fish and Game. Rainbow trout, Dolly Varden, smelt, and whitefish are common residents of the Kenai River drainages. Some tributaries now have populations of introduced northern pike (Alaska Dept. Fish and Game, 1976).

Nikiski area streams also support rainbow trout and Dolly Varden populations. Coho, pink, and sockeye salmon spawn in Swanson River and Bishop Creek. A major commercial herring fishery exists off Kenai to the Forelands.

Ninilchik

The 1970 population estimate for Ninilchik was 134 (Alaska Dept. Environmental Conservation, 1975). Seasonal employment during the summer inflates this number. The major industries in the community are fishing, recreation, and tourism.

Ninilchik is on the Sterling Highway, within easy access of Homer and Anchorage. A 2,500-foot long gravel-surfaced airfield serves nonscheduled air carriers from Kenai, Homer, and Anchorage. The small boat harbor has enough moorage space for 30 vessels (Table 14; Fig. 20). The harbor is accessible only at high tide, and the entrance channel must be dredged frequently.

Domestic water is supplied by individual wells and the Ninilchik River. Individual septic tanks accommodate sewage. Electricity is supplied by the city of Kenai. Solid waste is collected and disposed of at Homer (Fig. 21).

The Kenai Borough operates a school with enrollment of 176, serving grades 1-12. Total housing units censused in 1970 numbered 62, including 6 mobile homes, and 26 vacancies (Alaska Dept. Environmental Conservation, 1975). Inlet View Cabins has 14 rental units, and there is a 15-space public campground.

Outdoor recreation and tourism are becoming increasingly important to Ninilchik's economy (U.S. Army Corps Engineers, 1972). A steady flow of resident and nonresident vacationers travel to Ninilchik via the Sterling Highway in the spring and summer months. Their acitivites include digging for razor clams, fishing, sightseeing, camping, and photography. Parking, road access, and picnic spaces are available just off the Sterling Highway as well as near the mouth of Deep Creek.

Table 14 . Port and Harbor Facilities Summary, Ninilchik

Community: Ninilchik *Region:* Southcentral

Latitude: 60° 03' *Longitude:* 151° 40'

Waterway Locations: Cook Inlet ; ______

______ ; ______

Number of Facilities in Inventory: 1

Breakwaters: *No* X *Yes* ___ *Number* ___

Docks: *No* X *Yes* ___ *Number* ___

SB Harbors: *No* ___ *Yes* X *Number* 1

Canneries: *No* X *Yes* ___ *Number* ___

Floats: *No* ___ *Yes* X *Number* 1

Piers: *No* X *Yes* ___ *Number* ___

Freight Terminals: *No* X *Yes* ___ *Number* ___

Transshipment Points: *No* X *Yes* ___ *Number* ___

Passenger Terminals: *No* X *Yes* ___ *Number* ___

Boat Repair Grids: *No* X *Yes* ___ *Number* ___

Boat Launch: *No* X *Yes* ___ *Number* ___

Services Available:

Fueling: *No* ___ *Yes* ___

Boat Repair Yards: *No* ___ *Yes* ___

Marinas: *No* ___ *Yes* ___

Customs: *Complete* ___ *Limited* ___ *Request* X

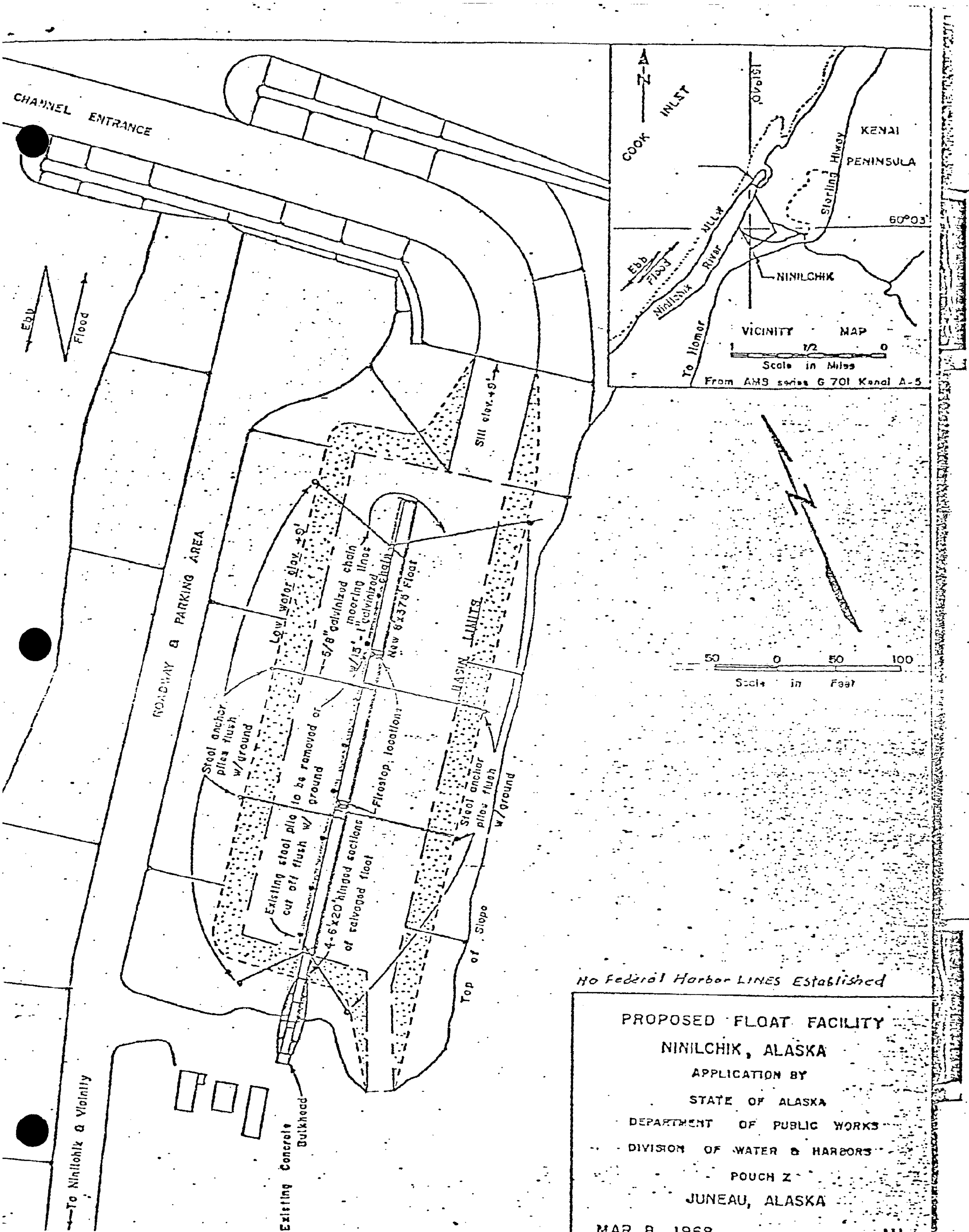


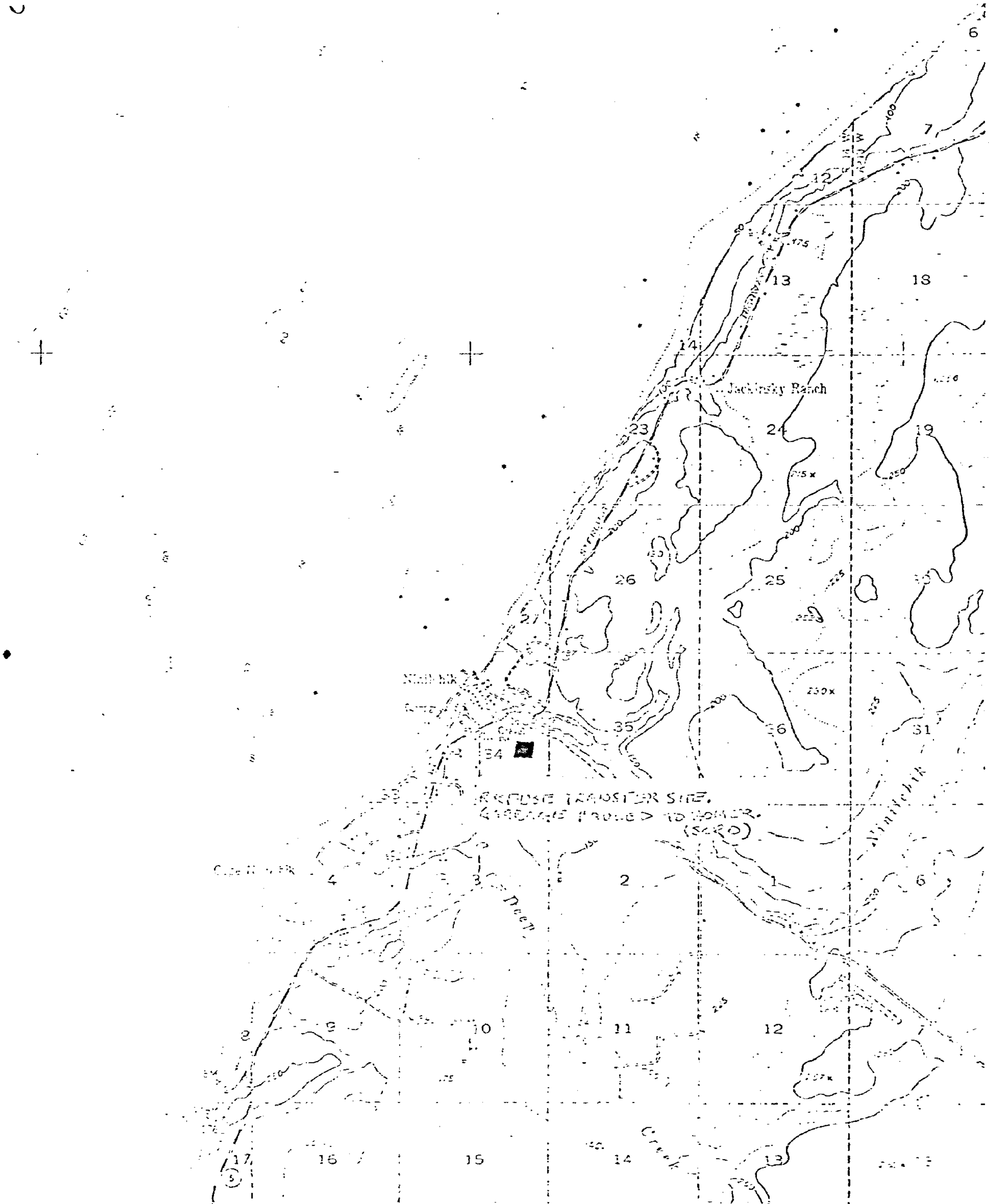
Figure 2a. Small boat harbor facilities in Ninilchik.

Figure 21. WASTE DISPOSAL: Ninilchik, Alaska

Outfalls inventoried in region: 3
Dump sites inventoried in region: 2

USGS Quadrangle: Kenai (A-5)

1:63,360



KEY

→	Outfall, raw sewage	○	Modified landfill
→	Outfall, treated sewage	▲	Open dump
→	Outfall, industrial sewage	+	Promiscuous dumping
●	Sanitary landfill	■	Transfer sites, incinerators, or recycling facilities

Rather substantial sport and subsistence hunting and trapping are conducted each year throughout the Ninilchik area. The Ninilchik River and Deep Creek support sport fisheries for chinook and coho salmon, Dolly Varden, and steelhead.

The small boat harbor (Fig. 20) is used primarily during the commercial salmon fishing season. This harbor has received increased use by sportsmen as interest in fishing for chinook salmon off the mouth of Deep Creek has increased (U.S. Army Corps of Engineers, 1972). The present lack of larger facilities and problems of access confine most sport fishing efforts to car-top boats which can be used only in calm weather.

There are no officially designated historic or archeological sites in the area, however, the old Russian Orthodox church is a popular tourist attraction.

Ninilchik is in a zone of high seismic risk (Fig. C-4). This risk carries the potential for major structural damage and loss of life due to severe ground shaking, local and regional uplift or subsidence, alterations of surface and groundwater hydrology, tsunamis, slope failure, and other phenomena.

The bluffs along the west shore of the Kenai Peninsula are eroding in the vicinity of Ninilchik (Stanley, 1967; U.S. Army Corps Engineers, 1974b). Beach erosion is also a problem, particularly north of the jetties (U.S. Army Corps Engineers, 1974b).

Winds in the Ninilchik area prevail from the southwest during summer and from north-northeast at other times. Maximum velocities occur from the latter direction (U.S. Army Corps Engineers, 1973b). Storm systems occurring almost every winter cause gusts of 50-70 knots. Offshore gusts frequently reach 75-100 knots. In late summer and fall, strong southerly post-frontal winds occur as a result of the movement of storms west and north of the region (Federal Power Commission, 1976). Breaker heights of 10-12 ft. may be generated within 24 hours by storm winds of 30 mph (U.S. Army Corps Engineers, 1974b). Under storm conditions, northward-moving littoral currents augment the flood tide current to produce a velocity of 5.4 ft/sec northward along the coast at Ninilchik. This velocity is nearly double normal flood velocities and may be assumed to be responsible for much of the littoral transport of sediments occurring in this area (U.S. Army Corps Engineers, 1974b). Net littoral transport of sediments along the entire west coast of the Kenai Peninsula from northwest of Homer to Nikiski appears to be northward (Alaska Dept. Environmental Conservation, 1976).

During winter, ice forms at the mouth of the Ninilchik River and in the Ninilchik small boat harbor. Fluvial ice from upper Cook Inlet is carried south through the Forelands into lower Cook Inlet, where it presents a hazard to navigation in the Ninilchik area for approximately 4 months each year (U.S. Army Corps of Engineers, 1974b).

Frequency of flooding is given as low for Ninilchik. However, coastal inundation from tsunamis is possible, as is coastal flooding resulting from storms and stream overflow from ice jamming along the Ninilchik River (U.S. Army Corps Engineers, 1976; Alaska Dept. Environmental Conservation, 1976).

Ninilchik is beyond the range in which volcanoes constitute a direct threat to human life. However, Ninilchik and other eastern Cook Inlet coastal communities are vulnerable to damaging ashfalls, acid rains, and tsunamis generated by explosive eruptions, mudslides, and other manifestations of volcanic activity (U.S. Army Corps Engineers, 1972; Kienle and Pulpan, unpubl. manuscr.).

Ninilchik represents a transition zone for subtidal and intertidal productivity along the east coast of Cook Inlet. The productive stands of kelp commonly found from Kachemak Bay northward up the coast give way to rather sterile conditions at Clam Gulch just north Ninilchik; this gravelly-sand beach has little algal cover in the mid and high intertidal zones (Alaska Dept. Environmenatl Conservation, 1976). Drift (detached) species documented for the area in September include Laminaria sp. and Agarum cribrosum in modest abundance, with Schizymenia epiphytica and Nereocystis leutkeana also common. Scattered razor clams and mussel valves on the beach indicate these invertebrates are present in some abundance. Water clarity decreases to the north in Cook Inlet, with a subsequent reduction in primary production as a general rule. Productivity values measured off Ninilchik by Larrance substantiate this statement (Fig. 3). Zooplankton populations occurring off the Ninilchik-Clam Gulch area can be seasonally high with significant larval crab and shrimp populations advected into the area from the south from March through August (Haynes, 1976). Razor clam larvae also contribute seasonally to zooplankton community biomass. Ichthyoplankton (fish eggs, larvae) are present in modest abundance. Herring schools feed off Ninilchik.

Tidal wetlands at the mouth of Deep Creek cover about 0.10 square miles and provide nesting and molting habitat for coastal waterfowl in the area (Alaska Dept. Fish and Game, 1976).

The Ninilchik area is heavily utilized by wintering moose populations. Brown and black bear and wolverine are present. Commonly observed small furbearers include muskrat, coyote, lynx, mink, and snowshoe hare. Spruce grouse and nesting/molting waterfowl populations inhabit the immediate coastal areas. Harbor seals and whales are present offshore in summer (Alaska Dept. Fish and Game, 1976).

Steelhead, rainbow trout, and Dolly Varden in the Ninilchik River and Deep Creek support an outstanding sport fishery (Alaska Dept. Fish and Game, 1976). Chinook, coho, and pink salmon spawn in these drainages. A major razor clam sport fishery extends from Anchor Point to Cape Kasilof. A major halibut fishing ground is also located offshore.

Anchor Point

The 1970 population estimate for Anchor Point was 102 (Alaska Dept. Environmental Conservation, 1975). The population increases during the summer. The major industries in the community are fishing and tourism, both are seasonal.

Anchor Point is connected to the Sterling Highway and has easy access to Homer (20 miles) and Anchorage (160 miles). Ten miles of State roads are also maintained in the area. Air transportation is provided by the Homer airport. No marine facilities are available for mooring vessels; dry storage is common.

Domestic water is supplied by individual wells. Septic tanks accommodate raw sewage. Electricity is provided by diesel facilities in Homer. Refuse is hauled to Homer for disposal (Fig. 22).

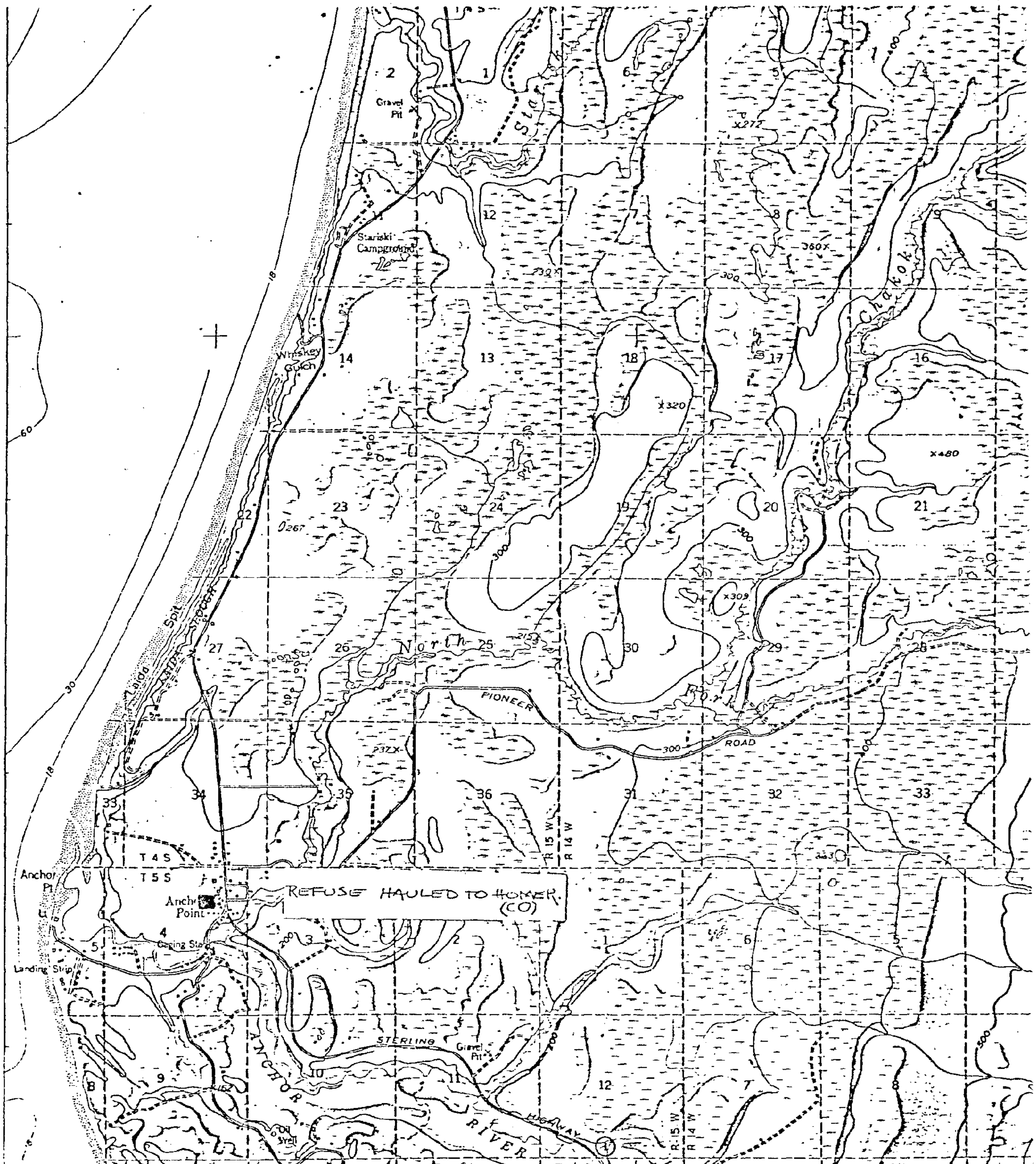
The Kenai Borough-operated school serves grades 1-8 with an enrollment of 91; students in grades 9-12 are bussed to Homer. Total housing units in 1970 numbered 30, including 4 mobile homes and 3 vacancies. The Anchor River Inn provides 10 rooms and there is a 7-unit State operated campground which is open to the public.

Tourism is a major source of seasonal employment at Anchor Point. Outdoor recreation and tourism show the most immediate promise for bolstering the community's economic activity. The Anchor River is well known for sport fishing. Excellent facilities for parking and camping where the river parallels the access road make this a major recreational area.

Figure 22. WASTE DISPOSAL: Anchor Point, Alaska

Outfalls inventoried in region:
Dump sites inventoried in region: 1

USGS Quadrangle: Seldovia (D-5) 1:63,36



KEY

→	Outfall, raw sewage	O	Modified landfill
→	Outfall, treated sewage	▲	Open dump
→	Outfall, industrial sewage	+	Promiscuous dumping
●	Sanitary landfill	■	Transfer sites, incinerators, or recycling facilities

Cutthroat and rainbow trout, Dolly Varden, chinook, coho, and pink salmon as well as halibut can be caught in the river or immediately offshore (Alaska Dept. Fish and Game, 1976). Beaches for hiking or beachcombing lie to the south. Campgrounds are maintained along the Anchor River by the Alaska Division of Lands. There is potential for development of additional public recreation facilities in the immediate vicinity of Anchor Point.

Anchor Point is in a zone of high seismic risk (Fig. C-5). There is potential for major structural damage and loss of life due to severe ground shaking, local and regional uplift or subsidence, alterations of surface and groundwater hydrology, tsunamis, slope failure, and other phenomena.

Frequency of flooding is given as high for Anchor point. Coastal inundation is possible from tsunamis, storms, and stream overflow resulting from ice jamming or excessive runoff in the Anchor River basin (U.S. Army Corps Engineers, 1976; Fig.C-5).

Active erosion has been occurring along the east shore of Cook Inlet from Kachemak Bay to Turnagain Arm (Stanley, 1967; U.S. Army Corps Engineers, 1974b). However, erosion is not indicated as a problem in the immediate vicinity of Anchor Point (U.S. Army Corps Engineers, 1974b).

Prevailing winds in the Anchor Point area are from the southwest during summer and fall. At other times, north-northeast winds prevail, with maximum velocities occurring from this direction (U.S. Army Corps Engineers, 1973b). During summer and fall, northward-moving littoral currents are generated by the winds (U.S. Army Corps Engineers, 1974b). The northward-moving littoral current velocity is nearly double normal flood velocities and, according to the Corps of Engineers, may be assumed responsible for much of the littoral transport of sediments in this area (U.S. Army Corps Engineers, 1974b).

During severe winters, local ice and floes from upper Cook Inlet occur along the eastern shore of Cook Inlet as far south as Anchor Point (U.S. Army Corps Engineers, 1974a; U.S. Dept. Interior, 1976). While much of this ice is soon beached or dispersed, it is frequently a navigational hazard (U.S. Army Corps Engineers, 1974b). In addition, ice jams occur on the Anchor River system (U.S. Army Corps Engineers, 1976).

Anchor Point is beyond the range in which volcanos constitute a direct threat to human life. However, Anchor Point and other coastal communities along Cook Inlet are vulnerable to damaging ashfalls, acid rains, and tsunamis generated by explosive eruptions, mudslides, and other manifestations of volcanic activity (U.S. Army Corps Engineers, 1972).

Tidal wetlands cover approximately 0.14 square miles between the protective headlands formed by bluffs flanking the Anchor River (Alaska Dept. Environmental Conservation, 1976; Fig. C-5).

Planktonic productivity is seasonably high off Anchor Point. The larvae of razor clams, Dungeness crab, shrimp, and other shellfish are very important components of the zooplankton community. Planktonic fish eggs are present in relatively high abundance in May. Anchor Point lies within the Bluff Point Crab Sanctuary, identified as a major crab breeding and larval release area in Cook Inlet.

Intertidal and subtidal productivity off Anchor Point is high. Major kelp beds are reported offshore; large quantities of *Agarum*, *Nereocystis*, *Laminaria*, and *Alaria* found washed up on the beach support this observation (Alaska Dept. Environmental Conservation, 1976). *Ptilota* and *Porphyra* are common red algae. Sea urchins (*Strongylocentrotus* spp.) and sea stars are common to abundant in the area (Lees, written commun.). Mussel populations are sparse.

Moose, coyote, wolverine, and black and brown bear are the larger terrestrial mammals found in the area. Sea otters, harbor seals and nesting and molting waterfowl are common coastal inhabitants.

The north and south forks of the Anchor River support spawning populations of chinook, pink, and coho salmon (Alaska Dept. Fish and Game, 1976). Cutthroat, rainbow trout, and Dolly Varden are common sport fish. Herring feed off the coast and a sport halibut fishery is thriving to the north of the area.

Homer

Latest population estimates for Homer are 1,243 (Alaska Dept. Environmental Conservation, 1975). The economy of Homer is based primarily on fishing, tourism, trade, and government.

Transportation facilities available include a 7,400 foot long asphalt surface airfield that is operated by the State with scheduled flights daily. Private float plane facilities are located on Beluga Lake. The city owns and operates a 480 foot dock on the Homer Spit with 36 feet of water at the face of the dock. Homer is served by the Alaska Marine Highway System. No crane or roll on/off facilities exist at the city dock to handle containerized cargo from ships. A small boat harbor serves more than 500 boats, including transients, and can be used at all stages of the tide. A public boat ramp is also available. Table 15 summarizes marine facilities available at Homer; Figure 23 shows existing dock facilities.

The city's water is stored in a 70 million gallon raw-water reservoir. It is chemically treated at the treatment plant and is stored in a 0.5 million gallon tank (Kelton, pers. commun.). Average domestic consumption is about 66,000 GPD; cannery requirements add significantly to this volume. Sewage is chlorinated and oxidated in two aeration lagoons with a wet-weather overflow structure (Fig. 24). Electricity is supplied by diesel powered generators with a 2,400 KW capacity.

Air quality measured as total suspended particulates (TSP) is reportedly poor in Homer. This fact may be more an artifact of where the measurements are taken (Main Street fire house) than the actual average quality (Hungerford, pers. commun.). Industrial atmospheric discharges are not significant at the present time.

Municipal solid wastes are disposed of at a trenched sanitary landfill in an old quarry (Fig. 24) with some septic tank pumpings and fish wastes probably added. Soil is generally nonporous in the area, creating a localized leachate problem. The groundwater table is high at time in the area of the landfill. Conditions at the Homer landfill are not suitable for industrial and/or hazardous wastes. Industry will have to initiate their own disposal methods subject to permits from the Department of Environmental Conservation.

The Homer hospital is staffed by 3 doctors and 20 nurses. The secondary school (grades 6-12) has an enrollment of about 400; the two elementary schools have a combined enrollment of over 300.

Homer's scenic beauty, mild climate, and excellent sport fishing make it an inviting location for both tourists and residents. There are two campgrounds in the area, the Homer Centennial Campground, west of the hospital, and the Homer Spit Campground. Two alpine ski slopes operate in the area--one slalom course and one recreational downhill course. Several miles of cross country ski trails are well maintained. The city also maintains a large fairground (Alaska State Housing Authority, 1969a).

Commercial fishing for salmon, halibut, crab, and shrimp is a mainstay of the local economy. Major sport fisheries for the same species have also developed in Homer; fishing for shrimp off the Homer Spit has become quite popular. Recreational boating is intensive during the summer season due primarily to the sport fishing activity. The Kachemak Bay wetlands are fairly accessible by boat from Homer and are popular hunting areas, particularly for waterfowl.

Homer is in a zone of high seismic risk (Fig.C-6). In addition to causing severe ground shaking, local and regional uplift or subsidence, alterations in hydrology, slope failure and other phenomena, earthquakes could produce submarine landslides and generate tsunamis (U.S. Army Corps Engineers, 1974a). During the 1964 earthquake, a 2-6 foot general subsidence occurred in the Homer area. An earthflow and several landslides on the slopes northeast of Homer also occurred. The quake left much of the Homer Spit below high tide levels, and a submarine landslide at the end of the spit destroyed much of the harbor breakwater (Foster and Karlstrom, 1967; Waller, 1966a).

Volcanic activity on the west side of Cook Inlet, particularly activity associated with Mount St. Augustine, could affect Homer. While the community is beyond the range which would constitute a direct threat to human life, it is close enough to be affected by ashfalls, acid rains, and tsunamis generated by this type of explosive volcano, as well as mudslides and other manifestations of volcanic activity (U.S. Army Corps Engineers, 1974; U.S. Dept. Interior, 1976).

Erosion has been identified as a problem in the Homer area (Farnen, written commun.). It became particularly severe after the 1964 earthquake, especially on the Homer Spit, where the highway, harbor, and dock were destroyed. The spit was almost broached at the narrowest point due to subsidence, and that area is still subject to considerable sediment movement. The Cook Inlet side of the spit is especially vulnerable to erosion from southwesterly storms, as are the bluff areas nearby. On the Kachemak Bay side, a piling and plank groin was washed away during a storm in 1974, only a few months after it was installed (Farnen, written commun.).

Serious flooding has never occurred at Homer (Farnen, written commun.). However, there is potential for flooding in low-lying areas from a tsunami (U.S. Army Corps Engineers, 1974a). Although the probability for a tsunami to occur in Cook Inlet is slight, one could occur, and it would cause damage to shore structures and boats in shallow water. A "krakatoan" eruption of Mount St. Augustine would be capable of producing a destructive tsunami, which could render great damage to coastal populations and facilities along the Homer Spit (U.S. Army Corps Engineers, 1974a).

Ice in the Homer area is described as being mostly a nuisance, occassionally blocking the dock and harbor. Ice has been known to damage the city dock on the Kachemak Bay side of the spit (Farnen, written commun.) and restrict small boat traffic during severe winters.

Tidal wetlands border the causeway adjacent to Beluga Lake and cover about 0.3 square miles (Table 3). These areas retain a meadowlike character of grasses and sedges and wildlife use typical of tidal wetlands. Limited areas of stressed tidal wetlands occur at the very base of the Homer Spit. Areas on the seaward side are stressed by erosion; sediment transport stresses the landward side.

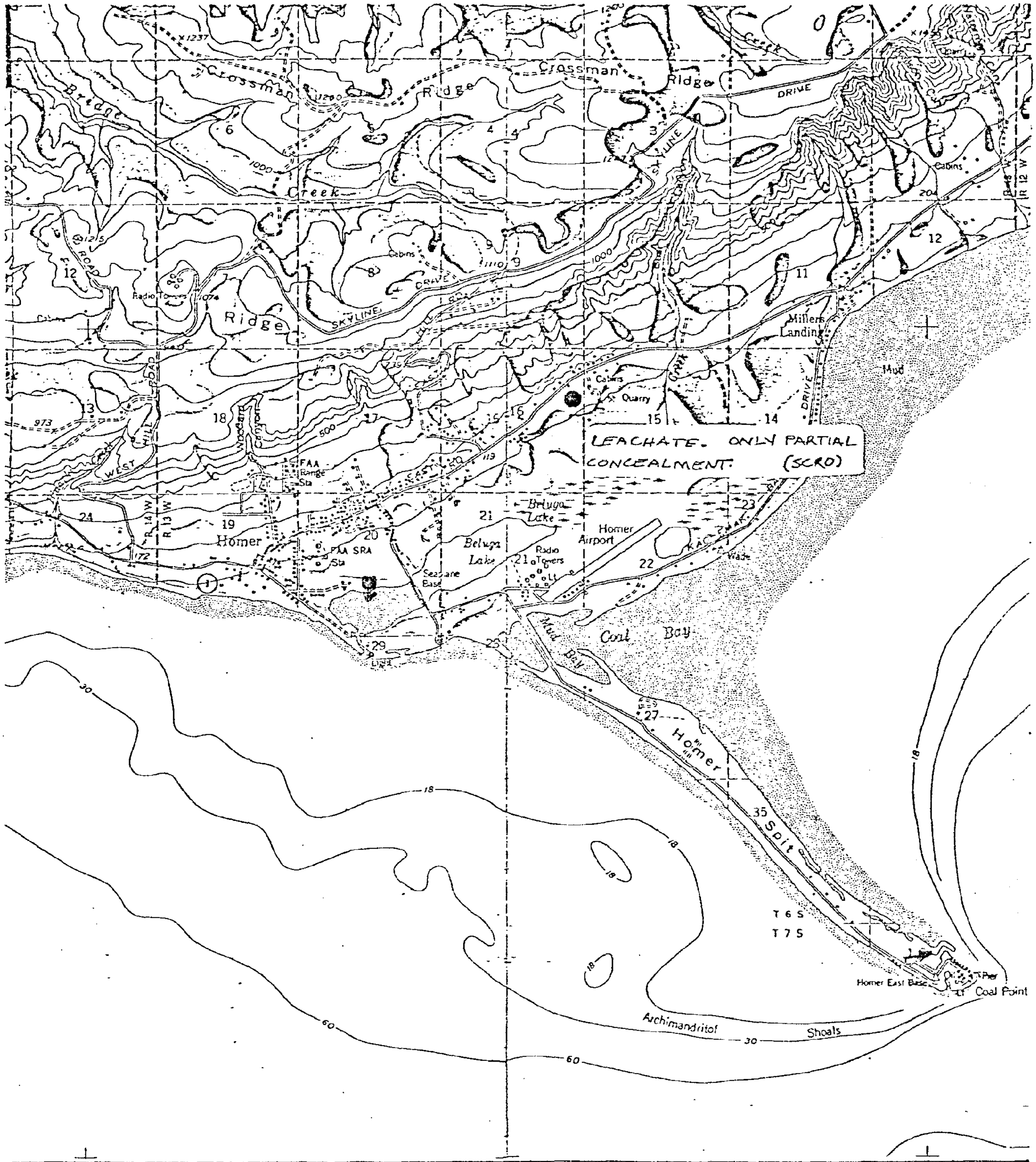
The nearest significant tidal and contiguous fresh water wetlands occur at the head of Kachemak Bay on the Fox River delta and along the south shore of the Bay. The tidal wetlands of the Fox River delta cover about 8.2 square miles (Alaska Dept. Environmental Conservation, 1976). Along the south shore of the bay, McKeon Flats, China Poot Bay, Halibut Cove, Grewingk Creek delta, and Aurora Lagoon have small to moderately sized tidal wetlands (Table 3).

Intertidal standing stock in the Homer vicinity is moderate to heavy (Alaska Dept. Environmental Conservation, 1976). Predominantly gravelly-sand and sandy-gravel beaches support moderate stands of seaweeds including-- *Fucus*, *Ulva*, *Porphyra*, and *Halosaccion*. Sea urchins are common to abundant. Mussels and barnacles are present in low abundance due to the paucity of large boulders. A significant growth of subtidal algae (Phaeophyceae) is present on the Inlet (outer) side of the Homer Spit, as inferred from the quantity of beach drift specimens and direct observation (Lees and Rosenthal, 1975). Major genera include, *Nereocystis*, *Alaria*, *Agarum*, and *Laminaria*. Windrows of eelgrass are present on the bayside beaches of the spit but are absent from the outside. Cockle valves are commonly found on inside beaches of the spit. *Nereocystis* and *Agarum* were not found on the inside beaches of the spit or along the north shore of Kachemak Bay, indicating the absence of large kelp beds in the inside waters. Littoral survey sites (ADEC) are indicated in Figure 25 .

Figure 24 . WASTE DISPOSAL: Homer, Alaska

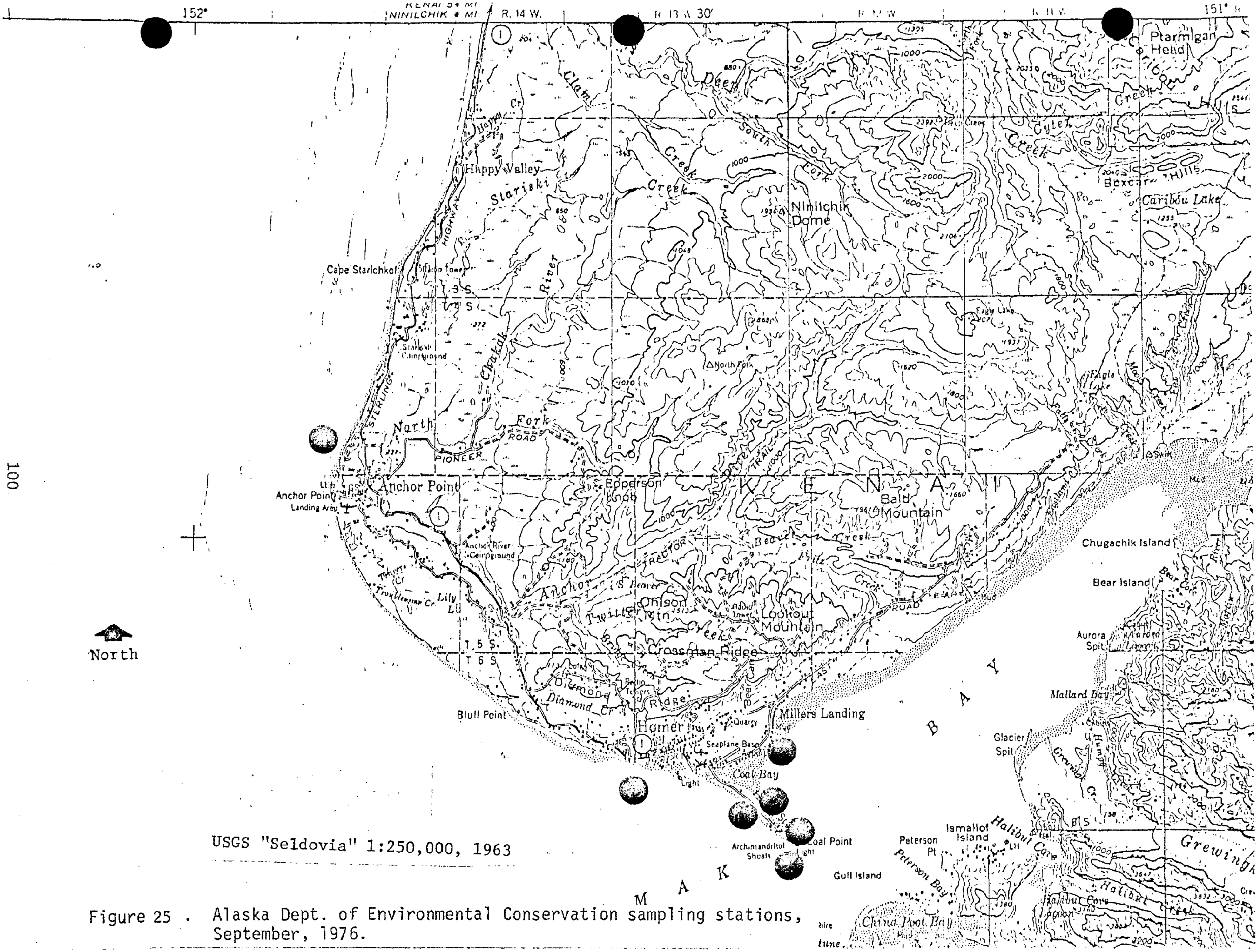
Outfalls inventoried in region: 10
Dump sites inventoried in region: 1

USGS Quadrangle: Seldovia (C-4, C-5) 1:63,360



KEY

⟶	Outfall, raw sewage	○	Modified landfill
●⟶	Outfall, treated sewage	▲	Open dump
⟹	Outfall, industrial sewage	+	Promiscuous dumping
●	Sanitary landfill	▬	Transfer sites, incinerators, or recycling facilities



USGS "Seldovia" 1:250,000, 1963

Figure 25 . Alaska Dept. of Environmental Conservation sampling stations, September, 1976.

Plankton prodictivity in Kachemak Bay is seasonally very high, with values of up to 8 $gC/m^2/day$ measured in early May (Larrance, pers. commun.). Williamson (1969) has described typical phytoplankton community assemblages from the relatively clear waters of Kachemak Bay to be mostly diatoms. Secondary production (zooplankton) is also high; the significance of the shellfish larvae released near the Bluff Point area to the maintenance of the productive shellfish industry of Cook Inlet was discussed earlier. Larvae of various shellfish species are in the water column from March through September (Haynes, 1972). Planktonic fish eggs are abundant from early to late May (English, written commun.).

Fish and wildlife resource values in the Homer region are very high, particularly for the marine resources (Table 11). Fox River is an important migratory stop over and nesting and molting area for many species of waterfowl (Alaska Dept. Fish and Game, 1973). Black and brown bears, wolves, and moose use the tidal and fresh water wetlands adjacent to streams in the area for foraging or hunting at various times of the year (Alaska Dept. Fish and Game, 1973).

Harbor seals, sea otters, and whales are commonly found in Kachemak Bay. Kachemak Bay salmon resources are significant, with the commercial catch in 1973 totalling 126,407 salmon of all five species (U.S. Army Corps Engineers, 1974). Pink and chum salmon runs into the bay are substantial and four major intertidal spawning areas for these species are found along the southern coast of the bay from Halibut Cove north (U.S. Dept. Interior, 1976). Pink and chum salmon are particularly vulnerable to oceanic pollution, both because they often spawn intertidally and the majority of their life history is spent in salt water. Herring spawn in the intertidal and near subtidal zone across the bay at Halibut Cove and some distance north.

Commercial crabbing and shrimp are intensive in Kachemak Bay. Historic king crab landings in Kachemak Bay are listed in Table 16. The location of fishing effort is indicated in Figure A3. The reduction in king crab catch since 1964 reflects a shift in effort from Cook Inlet toward Kodiak and westward. A quota system was established in 1969 to further distribute effort from Kachemak Bay to Kamishak Bay. Two million pounds is the allowable annual catch in the Kachemak (southern) district.

Commercial tanner crab harvest from Cook Inlet exceeded 8 million pounds in 1973 (Alaska Dept. Fish and Game, 1974). Major fishing grounds are located at the mouth of Kachemak Bay and east of Augustine Island. Dungeness crab catches in Cook Inlet are made predominantly in Kachemak Bay, from June through October (Flagg, 1972). Adult Dungeness crab seasonally move in and out of Kachemak Bay, migrating to shallow waters in spring and summer for molting and mating and returning to deeper waters in fall and winter. Juveniles generally rear for several years in shallow waters. King and tanner crab exhibit a similar migratory behavior.

Shrimp harvested in Cook Inlet come almost entirely from Kachemak Bay. Pink shrimp are the most abundant of the five species taken in the bay. A 5 million pound annual quota is presently in effect for Cook Inlet.

Traces of butter sole, pollock, and Pacific cod are present at the mouth of Kachemak Bay from June to September (Blackburn, written commun.).

Table 15. Port and Harbor Facilities Summary, Homer

Community: Homer *Region:* Southcentral

Latitude: 59° 35' *Longitude:* 151° 30'

Waterway Locations: Kachemak Bay ; ____

____ ; ____

Number of Facilities in Inventory: 3

Breakwaters: No ___ Yes X Number 1

Docks: No ___ Yes X Number 3

SB Harbors: No ___ Yes X Number 1

Canneries: No ___ Yes X Number 1

Floats: No ___ Yes X Number 1

Piers: No X Yes ___ Number ___

Freight Terminals: No X Yes ___ Number ___

Transshipment Points: No ___ Yes X Number 3

Passenger Terminals: No ___ Yes X Number 1

Boat Repair Grids: No ___ Yes X Number 1

Boat Launch: No ___ Yes X Number 1

Services Available:

Fueling: No ___ Yes X

Boat Repair Yards: No ___ Yes X

Marinas: No ___ Yes ___

Customs: Complete ___ Limited ___ Request X

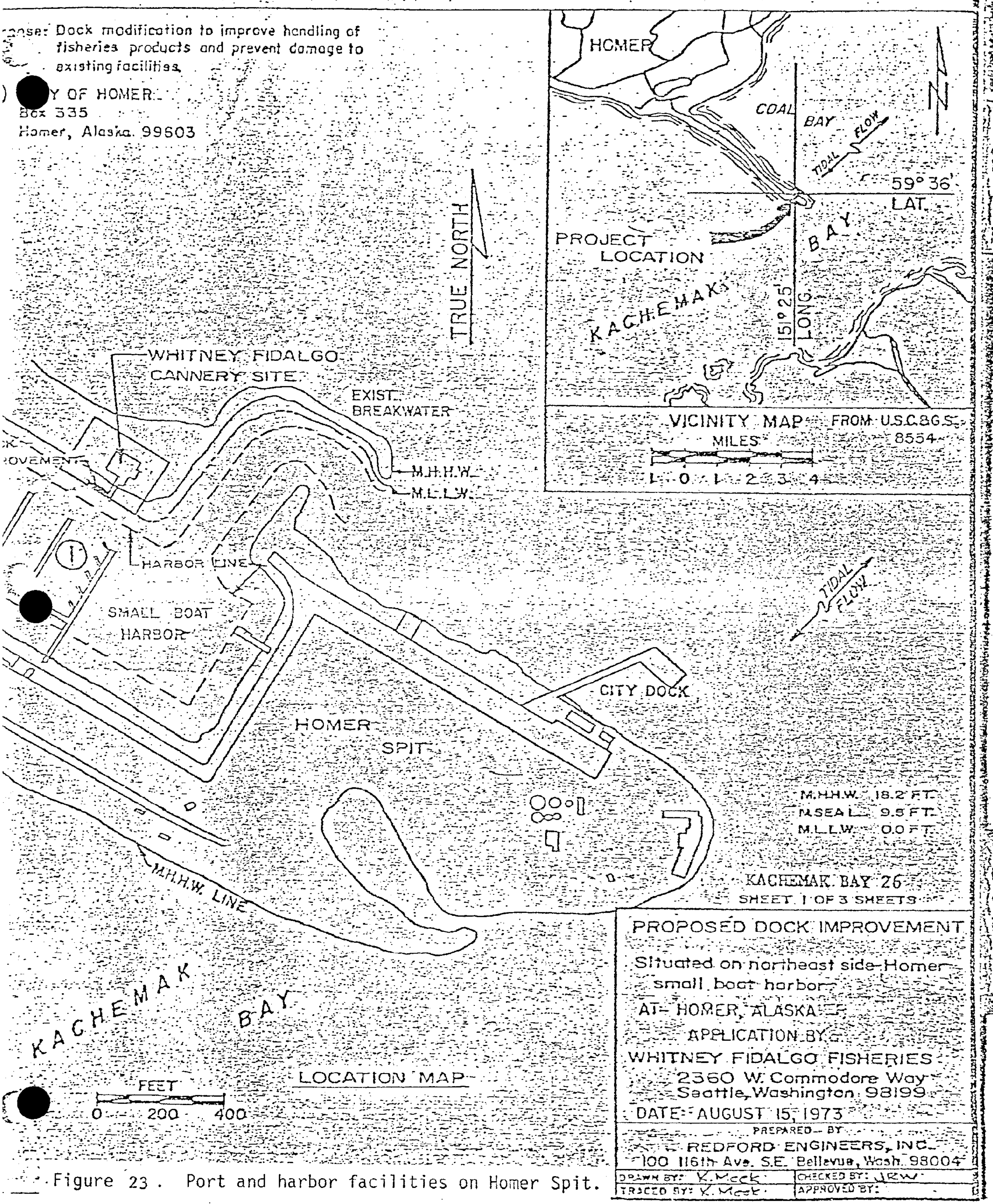


Figure 23. Port and harbor facilities on Homer Spit.

TABLE 16

KING CRAB HARVEST (POUNDS) COOK INLET

Year	Kachemak	Kamishak	Outer	Barren Island	Total	Vessels
1951	6,619				6,619	
1952	2,900				2,900	
1953	1,359,854				1,359,854	12
1954	1,275,852				1,275,852	7
1955	1,915,821				1,915,821	12
1956	2,129,035				2,129,035	12
1957	620,858				620,858	5
1958	752,990				752,990	5
1959	2,191,437				2,191,437	25
1960	4,219,776		67,656		4,287,432	60
1961	2,988,880	1,205,679	61,837		4,256,396	71
1962	1,968,980	4,305,444	577,197		6,851,621	70
1963	2,667,279	5,538,349	175,535		8,381,163	50
1964	1,760,660	4,967,824	43,908		6,772,392	46
1965	1,813,135	963,412			2,776,547	23
1966	1,887,948	1,974,559	37,656		3,900,163	33
* 1967	1,286,789	1,821,269	16,033		3,124,509	34
1968	1,004,683	2,965,658	39,112		4,009,453	44
1969	1,299,527	1,422,052	130,928		2,852,507	29
1970	1,495,759	2,237,259	149,784		3,882,802	41
1971	1,237,802	2,538,947	380,890		4,157,639	54
1972	2,032,871	2,427,769	232,689		4,693,329	48
1973	2,128,706	2,016,891	4,244	305,353	4,455,194	63

* 418 Pounds were landed from the Eastern District in 1967 and are included in the total.

1/ Source: U.S. Bureau of Commercial Fisheries.

In: USDI, Alaska OCS Office, Lower Cook Inlet Draft Environmental Impact Statement, Vol. I, 1976

Seldovia

The 1974 population estimate for Seldovia was 612 (Alaska Dept. Environmental Conservation, 1975). The economic base is not diverse; fisheries, forest products, and tourism are the major industries. Transportation facilities available in 1975 included 6.1 miles of locally maintained roads and 12.75 miles of state road (Alaska Dept. Environmental Conservation, 1975). A 2,100 ft. long gravel airfield operated by the city serves the one locally based nonscheduled air carrier. There are six docks in Seldovia harbor ranging from a 210 ft long city owned dock to a 24 ft. long facility operated by Kroll Packing Company (Table 17). Two canneries are presently operating in Seldovia. A small boat harbor serves the local fishing fleet and visiting small craft (Fig. 26). It can accommodate approximately 100 boats from 23 to 100 feet long (U.S. Army Corps Engineers, 1972). The Seldovia Community Comprehensive Plan of 1969 proposed to request that the Corps of Engineers dredge the harbor area to accommodate larger boats.

Seldovia's water supply comes from two small drainage basins. The upper basin serves as the primary source (reservoir); Fish Creek is used as the backup supply when the reservior is frozen or dry (Alaska Dept. Environmental Conservation, 1976). Water from both sources is chlorinated. Failure of both sources has occurred and the water system is being upgraded (pumps, flow meters, repaired pipes, water survey). Current reservior storage capacity ranges from 26 million gallons with an average domestic and industrial usage of 250,000-350,000 GPD, with maximum consumption of 500,000 GPD. Maximum daily demand on the sources is unusually high for a community of 612.

Table 17. Port and Harbor Facilities Summary, Seldovia

Community: Seldovia *Region:* Southcentral

Latitude: 59° 26' *Longitude:* 151° 43'

Waterway Locations: Seldovia Bay ; ______

______ ; ______

Number of Facilities in Inventory: 8

Breakwaters: *No* ___ *Yes* X *Number* 1

Docks: *No* ___ *Yes* X *Number* 6

SB Harbors: *No* ___ *Yes* X *Number* 1

Canneries: *No* ___ *Yes* X *Number* 2

Floats: *No* ___ *Yes* X *Number* 2

Piers: *No* X *Yes* ___ *Number* ___

Freight Terminals: *No* ___ *Yes* X *Number* 1

Transshipment Points: *No* ___ *Yes* X *Number* 8

Passenger Terminals: *No* X *Yes* ___ *Number* ___

Boat Repair Grids: *No* ___ *Yes* X *Number* 2

Boat Launch: *No* X *Yes* ___ *Number* ___

Services Available:

Fueling: *No* ___ *Yes* X

Boat Repair Yards: *No* ___ *Yes* ___

Marinas: *No* ___ *Yes* ___

Customs: *Complete* ___ *Limited* ___ *Request* X

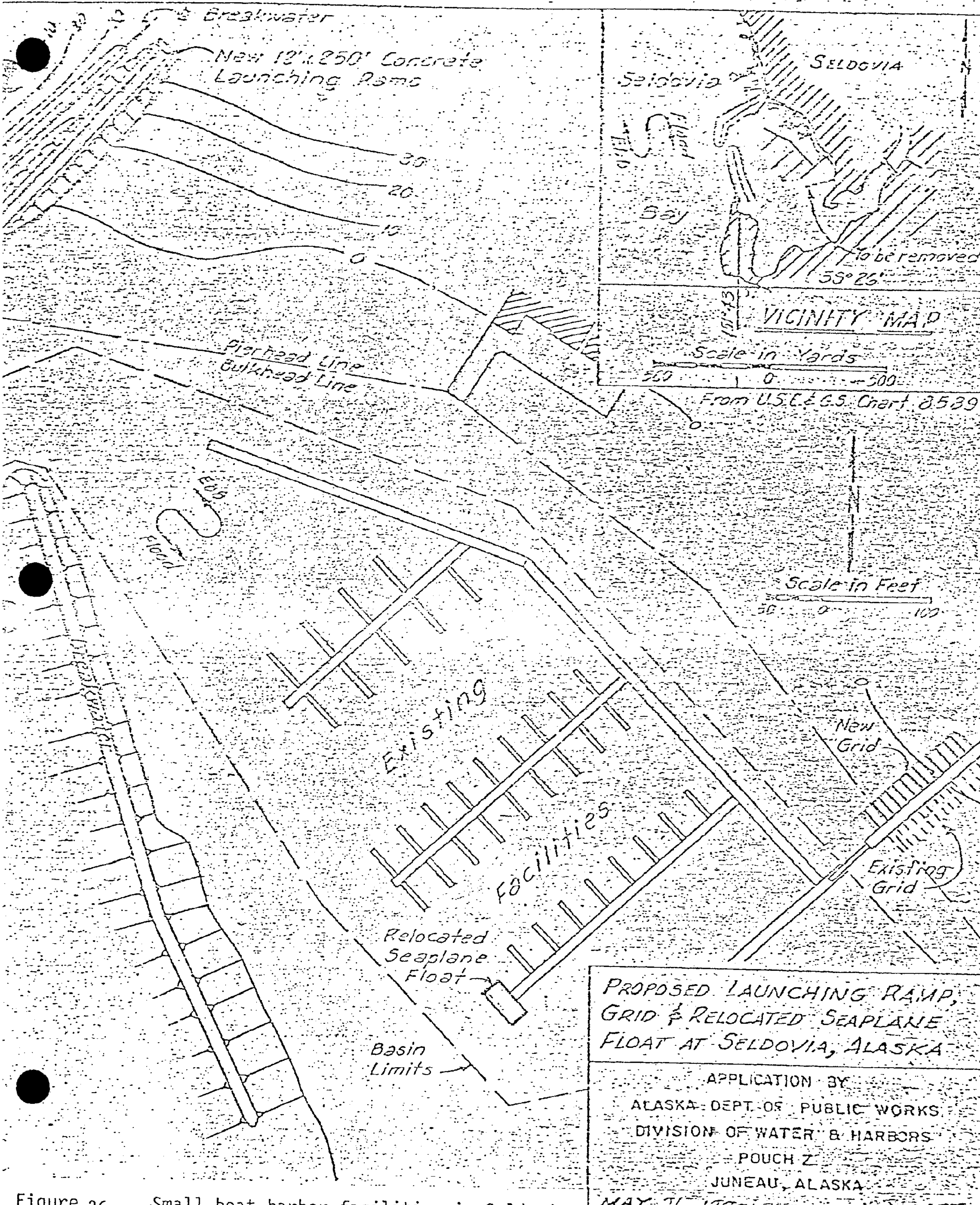


Figure 26 . Small boat harbor facilities in Seldovia.

Municipal solid wastes are disposed of at a modified landfill (Fig. 27). Some problems exist with winter collection and disposal and leachate. The landfill is in a ravine, risking possible contamination of Irlen Lake. The present disposal site is not highly suitable (Alaska Dept. Environmental Conservation, 1976). Sewage is collected and disposed through an outfall into Cook Inlet. Electricity is supplied by diesel-powered generators with a capacity of 1600 KW.

One school serves the community with an enrollment of 164. A 1970 housing census showed 153 housing units including 22 mobile homes and 21 vacancies. The Seldovia Lodge has 19 rooms.

Because of its picturesque setting, Seldovia has high potential for increased tourism, but tourist facilities are very limited. Revitalization of the waterfront boardwalk area has been proposed to improve the tourist trade (Alaska State Housing Authority, 1968). There is a camping and picnicking area at the outside beach about 1 1/4 miles from downtown Seldovia. This is a very scenic area with outstanding camping potential. It is conceivable that a conflict could arise between local and outside use, because this is one of the few suitable and easily accessible sites around Seldovia.

Seldovia Bay is a narrow protected inlet which offers the city a natural ice-free harbor for storage of boats and drilling rigs and a base for its fishing fleet. Harbor depth could be a future limitation to siting some types of facilities. There are no roads connecting the city to the rest of the peninsula (Alaska State Housing Authority, 1969b), although a secondary road connects Seldovia and Jakolof Bay.

Figure 27. WASTE DISPOSAL: Seldovia, Alaska

Outfalls inventoried in region: 3
Dump sites inventoried in region: 1

USGS Quadrangle: Seldovia (B-5) 1:63,360

KEY

Outfall, raw sewage	Modified landfill
Outfall, treated sewage	Open dump
Outfall, industrial sewage	Promiscuous dumping
Sanitary landfill	Transfer sites, incinerators, or recycling facilities

Seldovia has a variety of pleasant beaches, sea cliffs, wooded inlets, and tidal flats near town. There are small tidal and contiguous fresh water wetlands on the delta at the head of Seldovia Bay. The potential for hiking, sightseeing, and waterfowl hunting recreation may be overshadowed by the abundant alternate recreational possibilities. Across the inlet there is a small area of wetlands behind Point Naskowhak (Fig. C-8).

Seldovia is in a zone of high seismic risk (Fig. C-8). This risk carries the potential for major structural damage and loss of life from severe ground shaking, local and regional uplift or subsidence, alterations to surface and groundwater hydrology, tsunamis, slope failure, and other phenomena (U.S. Army Corps Engineers, 1974a).

During the 1964 earthquake, Seldovia subsided 3.7 feet (Foster and Karlstrom, 1967). It was also noted that damage to structures resulting from that earthquake was moderated by the inherent stability of bedrock underlying Seldovia (Alaska State Housing Authority, 1969).

Frequency of flooding for Seldovia is rated high to average by the Corps of Engineers. The mechanisms for the flooding are listed as tsunamis and storms causing coastal inundation (U.S. Army Corps Engineers, 1976).

Tsunamis resulting from landslides and seafloor displacement associated with volcanic and seismic activity in Cook Inlet represent a threat of coastal inundation to Seldovia. The Mt. St. Augustine eruption of 1883 generated a mudflow which created a tsunami (Fig. C-8) that was observed at Seldovia (Cox and Pararas-Carayannis, 1969). The community is also vulnerable to ashfall and acid rains generated by volcanic eruptions (U.S. Army Corps Engineers, 1972).

Intertidal and subtidal productivity in the inside waters of Seldovia Bay is reportedly moderate (U.S. Dept. Interior, 1976). The littoral zone to the north of Seldovia at Seldovia Point has been extensively surveyed (Lees and Rosenthal, 1975). The exposed intertidal zone of Seldovia Point is composed of cobbles and boulders. Rock surfaces are dominated by the brown algae *Alaria*, *Hedophyllum*, and *Fucus*; *Halosaccion* and *Rhodymenia* are conspicuous red algae during summer. Barnacles and sea urchins are common invertebrates in this area. The largest kelp beds in Kachemak Bay are found in the vicinity of Seldovia Point. *Alaria fistulosa* is the dominant species in the floating canopy during the summer.

Phytoplankton productivity in Seldovia Bay is undoubtedly high (Alaska Dept. Environmental Conservation, 1976) due to ideal mixing conditions and summer water column stratification properties of the bay. Values measured in nearby Kachemak Bay (8g $C/m^2/day$) seem to bear this out. Crab and shrimp planktonic larval stages and fish eggs are significant components of the spring/summer zooplankton community in coastal bays of the outer Kenai Peninsula (U.S. Dept. Interior, 1976)

Fish and wildlife resources in the Seldovia region are significant (Alaska Dept. Fish and Game, 1973; 1976). Harbor seals, wintering populations of waterfowl (primarily golden eyes), mountain goats, and black bear are common residents. Spruce grouse and small furbearers are plentiful. Pink, chum, and coho salmon spawn in the Seldovia River (Alaska Dept. Fish and Game, 1976). Estimated pink salmon escapements to streams along the outer Kenai Peninsula are shown in Table 18. Escapement to the Seldovia River in 1974 was 13,700 pinks. Escapement goals established for Seldovia Bay are 18,000-24,000 pink salmon (Alaska Dept. Fish and

Table 18. Estimated pink salmon escapements, Cook Inlet area, Southern and Outer Districts, in thousands of fish, 1962 - 1974 1/ 2/.

Stream	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Humpy	56.0	34.7	18.5	28.0	30.0	25.0	24.7	5.4	55.2	45.0	13.8	36.9	17.4
Tutka	30.0	10.0	20.0	20.0	12.0	7.0	7.9	6.5	6.5	16.7	1.5	6.5	2.6
Seldovia	50.0	15.0	60.0	30.0	86.0	55.0	53.2	60.0	23.0	31.1	5.8	14.5	13.7
Port Graham	50.0	2.0	16.0	1.5	24.0	2.0	24.4	4.0	16.6	13.2	2.4	7.0	2.8
Windy Left	12.5	4.5	7.7	10.0	7.0	6.0	6.9	23.0	13.0	35.4	.4	12.9	.1
Windy Right	12.5	4.9	6.2	2.0	7.0	6.0	2.8	3.2	2.1	13.0	.1	4.6	.1
Rocky	200.5	12.0	80.0	.3	44.0	1.0	43.1	1.0	32.0	1.6	8.1	2.0	1.5
Port Dick 3/	40.0	16.0	31.5	50.0	35.0	20.0	29.0	12.0	34.5	97.8	10.0	26.4	1.5
Island	15.0	3.6	30.0	.5	7.0	.5	4.3	.1	5.5	.1	1.7	.5	.5

In: USDI, Alaska OCS Office, Lower Cook Inlet Draft Environmental Impact Statement, Vol. 1, 1976

1) Source - A.D.F.&G., Cook Inlet Annual Reports.
2) The total escapement estimates were determined by graphing the available daily counts of pink salmon in the streams by magnitude and day and calculating the area under the graph. This figure is then divided by the estimated time the pink salmon are present in the stream, which averages 2.5 weeks.
3) A weir has been located on Port Dick Creek from 1971-1974. Total escapement estimates are calculated from ground and aerial surveys of fish spawning below the weir, plus weir counts of fish upstream.

Game, 1976) Dolly Varden are common stream residents. Herring feed in Seldovia Bay.

Major commercial king, tanner, and Dungeness crab and shrimping grounds are close to Seldovia. The Seldovia fleet contributes significantly to these fisheries and supports a seafood processing plant operated by Wakefield Fisheries, Inc. Halibut are also fished commercially out of Seldovia.

Port Graham

The 1970 population estimate for Port Graham was 107 (Alaska Dept. Environmental Conservation, 1975). The major industry of this native community is fisheries, with a seasonal economy based on a cannery operating during July and August (Kenai Peninsula Borough Planning Department, 1972). Transportation facilities include an 1,800 foot gravel surfaced airfield. There is no scheduled air service. No road system exists in the area. Sea-Land Incorporated and barge traffic from Homer serve the community. Port Graham does not have a small boat harbor. Launching ramps are available (Fig. 28). A docking facility provides a local transshipment point for cannery products (Table 19).

The domestic water supply system, constructed by the U. S. Public Health Service, consists of a dammed stream and reservoir, a chlorination and florination facility, and a pipe network (Alaska Dept. Environmental Conservation, 1975). Problems with this system (freezing pipes, low pressure, unreliable supply) are probably similar to those at nearby English Bay. Community and individual septic tanks are used for sewage disposal. Electrical demands are met by a 200 KW capacity diesel generator.

Port Graham operates an open dump at the end of the airfield runway (Fig. 29), with occasional burning of solid waste (Alaska Dept. Environmental Conservation, 1976). The U.S. Public Health Service is attempting to provide equipment for better maintenance of the facility.

The Borough operated school has an enrollment of 27. Total housing units censused by the U.S. Public Health Service in 1975 numbered 27 with no vacancies.

Table 19. Port and Harbor Facilities Summary, Port Graham

Community: Port Graham *Region:* Southcentral

Latitude: 59° 21' *Longitude:* 141° 49'

Waterway Locations: Cook Inlet ;

;

Number of Facilities in Inventory: 1

Breakwaters: *No* X *Yes* ___ *Number* ___

Docks: *No* ___ *Yes* X *Number* 1

SB Harbors: *No* X *Yes* ___ *Number* ___

Canneries: *No* ___ *Yes* X *Number* 1

Floats: *No* X *Yes* ___ *Number* ___

Piers: *No* X *Yes* ___ *Number* ___

Freight Terminals: *No* X *Yes* ___ *Number* ___

Transshipment Points: *No* ___ *Yes* X *Number* 1

Passenger Terminals: *No* X *Yes* ___ *Number* ___

Boat Repair Grids: *No* X *Yes* ___ *Number* ___

Boat Launch: *No* ___ *Yes* X *Number* 1

Services Available:

- *Fueling:* *No* ___ *Yes* X
- *Boat Repair Yards:* *No* ___ *Yes* ___
- *Marinas:* *No* ___ *Yes* ___
- *Customs:* *Complete* ___ *Limited* ___ *Request* X

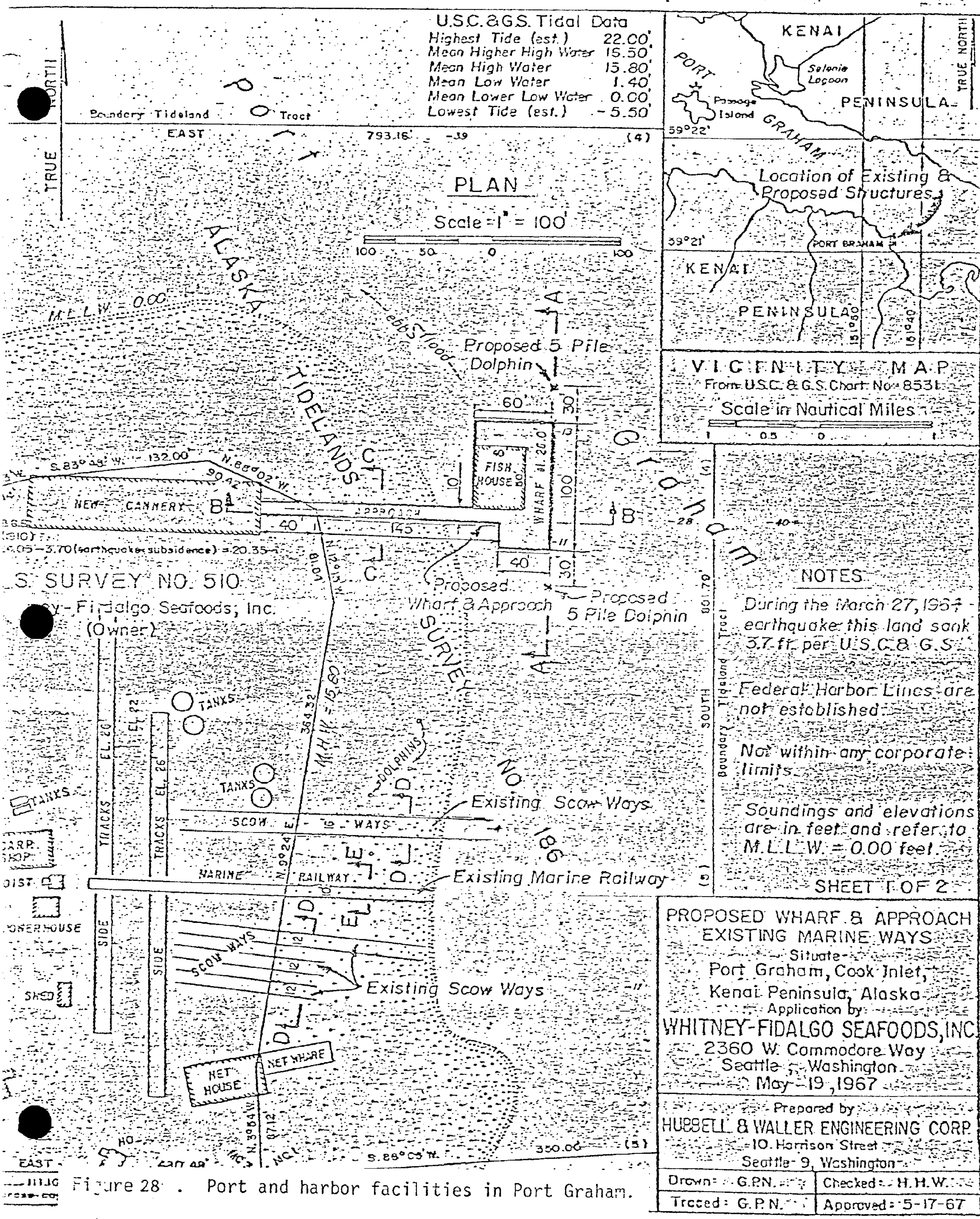
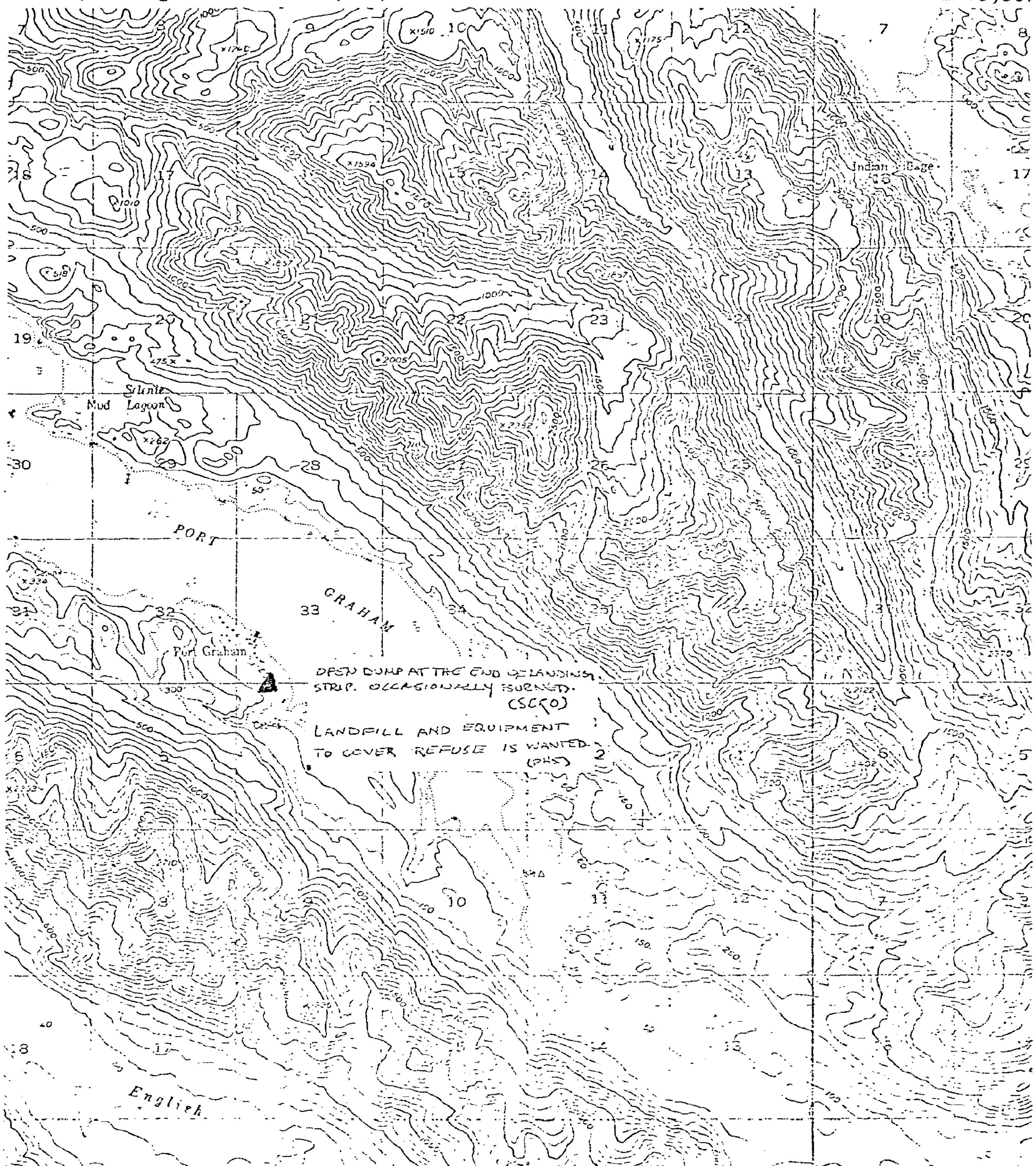


Figure 28 . Port and harbor facilities in Port Graham.

Figure 29 . WASTE DISPOSAL: Port Graham, Alaska

Outfalls inventoried in region: 3
Dump sites inventoried in region: 1

USGS Quadrangle: Seldovia (B-5) 1:63,36(



KEY

→	Outfall, raw sewage	O	Modified landfill
⇸	Outfall, treated sewage	▲	Open dump
➞	Outfall, industrial sewage	+	Promiscuous dumping
●	Sanitary landfill	■	Transfer sites, incinerators, or recycling facilities

Tourism apparently has limited economic potential for Port Graham, due to the lack of facilities to accommodate tourists. Because of its seasonal nature, tourism and recreational development are not likely to attract substantial capital investment. Until Port Graham's economic base increases, tourism will remain limited (Kenai Peninsula Borough Planning Dept., 1971).

In the Port Graham Comprehensive Development Plan of 1971, it is recommended that green belt areas be reserved around community water sources and along all coastal land. This would not only protect the natural quality of these resources, but would also provide community access for recreational and subsistence purposes.

Port Graham is within a zone of high seismic risk (Fig. C-9). This risk represents a potential for major structural damage and loss of life due to severe ground shaking, local and regional uplift or subsidence, alterations to surface and groundwater hydrology, tsunamis, slope failure, and other phenomena (U.S. Army Corps Engineers, 1974a). During the earthquake of 1964, Port Graham subsided 3.5 feet (Foster and Karlstrom, 1967).

Tsunamis associated with volcanic and seismic activity in Cook Inlet represent a threat of coastal inundation to Port Graham. The Mount St. Augustine eruption of 1883 generated a mudflow which in turn caused a tsunami (Fig.C-9) that struck English Bay causing minor damage (Davidson, 1884; Cox and Pararas-Carayannis, 1969). The community is also vulnerable to ashfall and acid rains generated by volcanic eruptions (U.S. Army Corps Engineers, 1972; U.S. Dept. Interior, 1976).

Some tidal wetland acreage exists at the head of the bay (Fig.C-9) as an upland transition from the subtidal eelgrass beds. Available information indicates some recreational potential and use of these weltands for berry picking and hunting. In the immediate vicinity of Port Graham these areas provide the major portion of flat open ground in an otherwise high relief area. Wetlands and the adjacent lands will probably become more valuable as both recreation areas and possible building and material sites if future OCS activity, renewed fisheries, or tourism should use the English Bay-Port Graham area as a base.

Phytoplankton productivity in Port Graham is probably comparable to that of inside waters of Kachemak Bay, because its protected nature allows the earlier onset of stratification, a condition that is maintained through summer. These conditions promote an extended period of phytoplankton production. The U.S. Food and Agriculture Organization (1972) estimate primary production in open waters of lower Cook Inlet at 250-500mg C/m^2/day. Zooplankton production is also expected to be high in embayments, with a strong larval crustacean component in that community. Ichthyoplankton are probably seasonally abundant in Port Graham, based on populations observed in Kachemak Bay.

Prominent wildlife resources in Port Graham include black bear, harbor seals, sea otters, mountain goats, wolf and wolverine. Small furbearers include mink, lynx, snowshoe hare, and beaver. Wintering waterfowl populations of golden eye, scoter, and harlequin ducks, red-breasted mergansers, and medium sized shorebirds use the bay (Alaska Dept. Fish Game, 1976). Pink salmon escapements to streams at the head of Port Graham in 1974 were 2,800, substantially lower than historic levels (Table 18). Escapement goals established for this system are 45,000-60,000 pinks. Dolly Varden, chum and coho salmon also spawn in streams that feed the head of Port Graham. Herring schools feed within Port Graham.

Stocks of king, Dungeness, and tanner crab, and shrimp are abundant in Kachemak Bay and in coastal embayments of the outer Kenai Peninsula and are commercially exploited by fishermen from Kenai, Homer, and Seldovia.

English Bay

The 1972 year-round population estimate for English Bay was 77 (Alaska Dept. Environmental Conservation, 1975). The community is not incorporated and a village council serves as the governing body. The fishing industry is the major source of employment (26 residents) and government secondary (Kenai Peninsula Borough Planning Dept., 1972). Employment is seasonal with little winter activity. Transportation facilities include a 2,000-foot gravel surface airfield; air transport is the typical method of access to the community from elsewhere in Alaska. No road system or locally-based air carriers operate in English Bay. A road has been proposed from English Bay to Port Graham along the approximate route of an existing footpath (Kenai Peninsula Borough Planning Dept., 1972). The Alaska Marine Highway System does not serve English Bay. Nearby Port Graham, offering deep protected water near shore, is served by Sea-Land Incorporated and barge service from Homer. Shallow water adjacent to English Bay precludes construction of a small boat harbor.

The domestic water supply system, which was built by the U.S. Public Health Service, consists of a log dam with a small reservoir, a chlorination house, and a 15,000 gallon storage tank (Kenai Peninsula Borough Planning Dept., 1972). The system is only marginally adequate, because approximately 75% of the water lines leading to homes freeze in the winter. Pressure during the summer is low. No fire-fighting capability exists. Sewage is disposed of in two gravel-filled pits.

English Bay uses an open dump (Fig. 30) with burning for solid waste disposal (Alaska Dept. Environmental Conservation, 1976). Containment, leachate, and winter collection problems are evident.

The Kenai Borough operates a school with an enrollment of 20. Twelve housing units existed in 1975 (U.S. Public Health Service, 1975). Electrical power is provided for the school by a diesel-powered portable generator. The rest of the town is without electrical power.

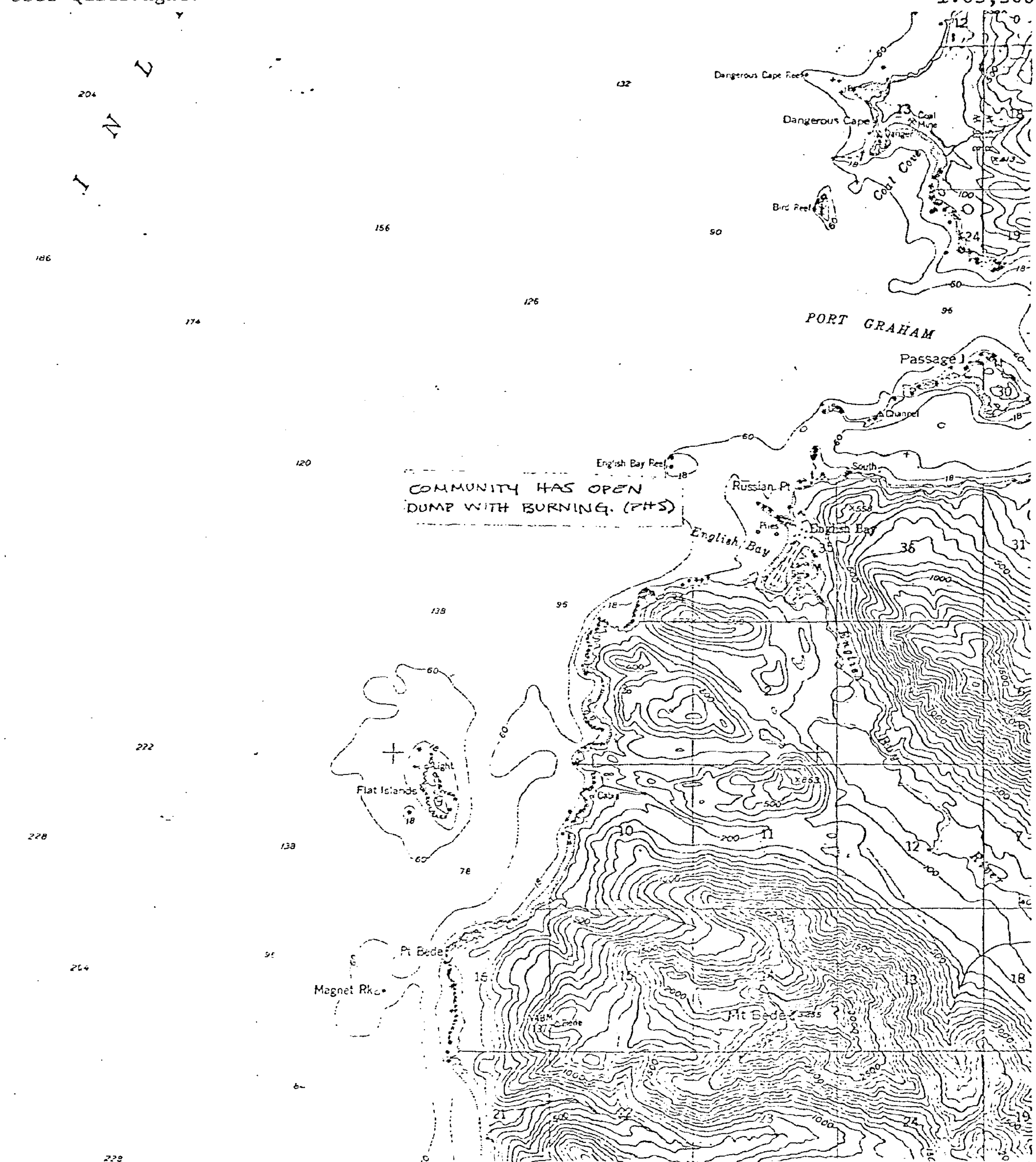
The Kenai Peninsula Borough Overall Economic Development Program states that employment opportunities in English Bay ". . . are derived either from fishing or government programs, both offer limited employment in the winter; during breakup construction activity is limited and fishing season is just getting underway. Consequently, employment is negligible for six months of the year."

According to a 1970 Alaska State Housing Authority program application, of the 77 permanent residents, 26 were employed during the summer in the fishing industry (mostly at the Port Graham cannery) and six were employed during the winter (four at the Kenai Peninsula Borough school). Other sources of employment are periodically found outside the village in the construction or janitorial fields. This form of employment, however, seldom accounts for more than one or two villagers. Another source of temporary employment is the autumn berry harvest. Alaska Wild Berry Products of Homer buys several types of berries picked by the villagers. This form of activity is carried out mostly by village children and women and no record is kept of actual employment.

Figure 30. WASTE DISPOSAL: English Bay, Alaska

Outfalls inventoried in region: O
Dump sites inventoried in region: 1

USGS Quadrangle: Seldovia (B-6) 1:63,360



KEY

Outfall, raw sewage	Modified landfill
Outfall, treated sewage	Open dump
Outfall, industrial sewage	Promiscuous dumping
Sanitary landfill	Transfer sites, incinerators, or recycling facilities

There appears to be potential for expanding economic and recreational opportunities in English Bay (Kenai Peninsula Borough Planning Dept., 1972). A road constructed to Port Graham, logging operations, development of a crafts market, expanded cannery facilities at Port Graham and tourism are all viable means of expanding the economic potential of the area.

The attractive physical setting, historic sites within the village, and the high quality sport fishing in the English River drainage combine to draw tourists to English Bay. Although many sport fishermen visit English Bay in the summer salmon season, the community has little to offer in the way of accommodations or services. Therefore tourists contribute little to the village economy (Kenai Peninsula Borough Planning Dept., 1972).

The largest area of public land, 12 acres, encompasses the village airport. There is beach fishing along this property, and the opposite side of the airstrip has a boat moorage site in a lagoon. The southern tip of the airfield, a greenbelt area, is primarily used for recreation. Remaining greenbelt areas are used for boat moorage, commercial and subsistence beach fishing, net storage, shellfish gathering, and collecting driftwood for firewood.

The Comprehensive Community Development Plan of 1972 recommended that greenbelts be expanded on all sides of the village. As the population increases, recreational use as well as subsistence gathering of shellfish and other foodstuffs are expected to increase. These activities depend on maintaining the natural qualities of the shoreline (Kenai Peninsula Borough Planning Dept., 1972).

English Bay is in a zone of high seismic risk (FigC-10). During the 1964 earthquake, English Bay and Port Graham subsided 3.5 feet (Foster and Karlstrom, 1967). Subsidence may be responsible for beach erosion on the English Bay Spit as indicated on FigureC-10. According to Vincent Kvasnikoff, President of the Village Council, more and more of the spit is covered by water every year (written commun.).

Frequency of flooding for English Bay is rated as low by the Corps of Engineers. However, stream overflow is possible, and tsunamis resulting from landslides and seafloor displacement associated with volcanic and seismic activity in Cook Inlet represent a threat of coastal inundation to English Bay (U.S. Army Corps Engineers, 1976). The Mount St. Augustine eruption of 1883 generated a mudflow which created a tsunami 20-30 feet high at English Bay, causing some damage (Davidson, 1884; U.S. Army Corps Engineers, 1972). The community is also vulnerable to ashfall and acid rains generated by volcanic eruptions (U.S. Army Corps Engineers, 1972).

Littoral zone productivity has been only superficially censused. Eelgrass beds are present in the bay, but kelp beds are less common here than around Port Graham (U.S. Dept. Interior, 1976). Concentrations of crustacean planktonic larvae (primarily Dungeness crab and shrimp) and fish eggs are seasonally found in English Bay, and throughout coastal bays of the outer Kenai Peninsula.

Black bear, mountain goats, harbor seals, and sea otters are predominant larger animals found near English Bay. Fur bearing animals such as mink, fox, lynx, coyote, wolverine, and muskrat inhabit the uplands near the village. The spruce grouse is common in the area. A variety of seabirds and migratory waterfowl frequent protected coastal areas.

The region's waters are an abundant source of commercial and sport fish. Trout, Dolly Varden, and spawning runs of pink, sockeye, and coho salmon are present in English Bay River. Halibut, salmon, shrimp, and Dungeness, king, and tanner crab are taken from offshore waters and within the bay. Clam beds occur in some intertidal areas of the beach.

POTENTIAL NONCOMMUNITY DEVELOPMENT LOCATIONS

Cape Starichkof

Cape Starichkof is located 7.5 miles north of Anchor Point and 14 miles south of Ninilchik on the Sterling Highway. The area has been recommended as the southern terminus for receiving, liquefying, and shipping natural gas from the North Slope if the El Paso route receives Congressional approval (Federal Power Commission, 1976a). This has led to further interest in the cape as a production treatment and terminal site for possible lower Cook Inlet oil production (Federal Power Commission, 1976b). The area is undeveloped except for a large gravel pit located near the prospective site, a few individual residences, and a planned subdivision north of Stariski Creek and west of the highway. Several other structures are in the area which is still largely wooded.

The 200-foot bluffs that shelve to the sea are stabilized by shrub growth. Stariski Creek passes to the east of the site. A beach berm system confines the creek near its mouth against the bluffs and protects a small tidal wetland area. The creek breaks through the berm north of the cape.

Rainbow and cutthroat trout are found in Stariski Creek. Chinook, coho, and pink salmon spawn in the creek. Offshore tidal flats support a major sport fishery for razor clams. Commercial set net fisheries for salmon operate along the beach. Commercial shrimping grounds lie offshore. Flounder and halibut are taken in the commercial fishery further offshore (Alaska Dept. Fish Game, 1976).

The waters off Cape Starichkof support seasonally high levels of planktonic productivity. Shellfish larvae and fish eggs are important components of this community during spring and summer. Intertidal and subtidal macrophyte cover is moderate to light. Wildlife populations and values for Cape Starichkof are similar to those of Anchor Point. Waterfowl use at Cape Starichkof may be limited because of its smaller area of tidal wetlands. However, there is no road access to the beach at the cape, and it is more isolated than the developed recreation area at Anchor Point. The wetlands at Cape Starichkof near the mouth of Stariski Creek are confined against the bluffs. As a result, a variety of landforms are found near each other. Given better access, Cape Starichkof would probably be a desirable recreational area.

Cape Douglas

Cape Douglas is the southernmost headland on Cook Inlet. It lies within the Katmai National Monument. This site has been identified as a potential oil terminal site in the event economic oil reserves are discovered in lower Cook Inlet (U.S. Dept. Interior, 1976). Sukoi Bay appears to be a likely anchorage in the area but will probably require substantial dredging to accommodate deep-draught vessels (Fig. C17). Tidal flats are found along several stretches of Sukoi Bay. Numerous reefs are scattered inside the bay. Shoreline acreage is available for facility siting in several areas, interspersed with bluffs. No known road system or airfield facilities are developed in the Cape Douglas vicinity. A number of lakes dot the Cape Douglas Peninsula and several rivers feed the southern waters of the bay.

Cape Douglas and vicinity is in a zone of high seismic risk. This risk represents a potential for major structural damage and loss of life due to severe ground shaking, local and regional uplift or subsidence, alterations to surface and groundwater hydrology, tsunamis, slope failure, and other phenomena (U.S. Army Corps Engineers, 1974a).

Tsunamis resulting from landslides and seafloor displacement associated with volcanic and seismic activity in Cook Inlet represent a threat of coastal inundation at Cape Douglas. Tsunamis originating from outside Cook Inlet could affect the Cape Douglas area, but according the the Department of the Interior (1976), the elongate geometry of Cook Inlet reduces the chance of such an occurrence.

In addition to volcanically-generated tsunamis, Cape Douglas is vulnerable to several other hazards associated with volcanic activity. Mud flows and floods generated by melting ice and snow on the slopes of Mt. Douglas could inundate areas around Cape Douglas. In addition, Cape Douglas is within range of pyroclastic flows, lava flows, heavy ash falls, explosive blasts, and earthquakes generated by the eruption of Mt. Douglas. The risk of such hazards from Mt. Douglas may be relatively remote because this volcano is classified "quiescent" (U.S. Army Corps Engineers, 1972). However, Cape Douglas would be subject to damaging effects from an eruption of Mt. Augustine 35 miles to the north. This volcano is active and is capable of producing damaging tsunamis, ashfalls, and explosive ash clouds (U.S. Army Corps Engineers, 1972).

Maximum winds in the Cook Inlet region can be severe, exceeding 75-100 knots over open water. Over Cook Inlet, storm systems generate gusts of 50-75 knots almost every winter (U.S. Dept. Interior, 1976). In late summer and fall, strong southerly post-frontal winds result from the movement of storms west and north of the region (Federal Power Commission, 1976). The south shore of Cape Douglas is exposed to such winds. Southwest gales on Shelikof Strait, south of the cape, raise a short heavy sea that is hazardous to small vessels (U.S. Dept. Commerce, Coast and Geodetic Survey, 1964).

In the area around Cape Douglas, fishermen have reported waves in excess of 20 feet during periods of severe weather in lower Cook Inlet. A combination of tides and winds can create a confused sea of high intensity, particularly in the lower reaches of the inlet. Periods of intense westerly "Chinook" winds with reported velocities in excess of 100 knots funnel through mountain passes west of Kamishak Bay, creating severe sea conditions in the western portion of lower Cook Inlet (U.S. Dept. Commerce, Coast and Geodetic Survey, 1964).

High concentrations of crustacean larval and juvenile stages are reported from southern Kamishak Bay. Juvenile tanner crab are particularly concentrated east of Cape Douglas (Feder, pers. commun.). Planktonic productivity is reportedly high within the Cape Douglas-Barren Islands-Augustine "triangle" (U.S. Dept. Interior, 1976). It is within this area that major commercial king and tanner crab fisheries are concentrated (Figs. A8 and A9). Planktonic fish eggs are abundant during summer in Kamishak Bay. Little is known of littoral zone productivity around the Cape Douglas headlands. Lees and Rosenthal (pers. commun.) found ice scouring of the intertidal zone in Kamishak Bay reduced biomass considerably. Disjunctly distributed kelp beds are found in Sukoi Bay with light cover around the outer coast of Cape Douglas (U.S. Dept. Interior, 1976). Tidal wetlands and eelgrass beds occur in bays and inlets of Kamishak Bay to the north of Cape Douglas (Table 4).

Sea otters are common in Sukoi Bay and along the outer coasts (Alaska Dept. Fish Game, 1976). High density harbor seal populations are also reported from Cape Douglas. Wintering waterfowl populations, high spring concentrations of brown bear along streams and abundant small furbearers characterize wildlife groups of the Cape Douglas vicinity. Dolly Varden, arctic char, and spawning pink salmon populations are found in major drainages along the southern coast of Cape Douglas. Few anadromous streams are documented for the headlands.

Inaccessibility, lack of permanent local facilities and transportation, and distance from population centers have limited human impact in the area. Cape Douglas does receive moderate recreational hunting pressure, primarily for brown bear. Major commercial fishing grounds for king and tanner crab lie offshore. Salmon are also commercially harvested in this area.

Tuxedni Bay

Tuxedni Bay has been proposed as a possible site for production treatment facilities associated with lower Cook Inlet oil and gas development (U.S. Dept. Interior, 1976). The extensive tidal flats and steep upland relief which characterizes much of Tuxedni Bay preclude building shore facilities in most areas without requiring substantial dredging. Fossil Point, however, is protected and has enough flat shoreline to accommodate industrial facilities. Offshore bathymetry near Fossil Point would allow use by deep-draught vessels with minimum dredging in Tuxedni Bay. Although there are no communities in the Tuxedni Bay area, there is a cannery in Snug Harbor on the southwestern coast of Chisik Island. This facility could be expanded to meet some industrial requirements. Although reefs are scattered at the mouth of the bay north of Chisik Island, Tuxedni Channel provides a safe access route to its inner waters.

Tuxedni Bay and vicinity is in a zone of high seismic risk (Fig. C-15). including the potential for severe ground shaking, local and regional uplift or subsidence, alterations to surface and groundwater hydrology, tsunamis, slope failure and other phenomena (U.S. Army Corps Engineers, 1974a).

Tuxedni Bay is vulnerable to several hazards associated with volcanic activity. Mudflows and floods generated by melting ice and snow on the slopes of Mt. Iliamna and Mt. Redoubt could inundate extensive areas along drainages near Tuxedni Bay. In addition, Tuxedni Bay is in the range of tremors, heavy ash falls, and explosive blasts that might accompany the eruption of either Redoubt or Iliamna. Mt. Iliamna is classified as active but quiesient (U.S. Army Corps Engineers, 1972). Mt. Redoubt is classified as active and potentially eruptive--it last erupted in 1966.

Tsunamis resulting from landslides and seafloor displacement associated with volcanic and seismic activity in Cook Inlet could cause coastal flooding around Tuxedni Bay. Tsunamis originating from outside Cook Inlet could also affect the area, but according to the Department of the Interior (1976), the elongate geometry of Cook Inlet reduces the chances of such an occurrence.

Fishermen have reported waves in excess of 20 feet in lower Cook Inlet during periods of severe weather. A combination of tides and winds can create a confused sea of high intensity, particularly in the lower inlet. Maximum winds in this area have exceeded 75-100 knots over open water (U.S. Dept. Interior, 1976). In late summer and fall, strong southerly post-frontal winds result from the movement of storms west and north of the region (Federal Power Commission, 1976). In Tuxedni Channel, heavy williwaws, or sudden blasts of strong pulses of wind, occur with gales from any direction, creating choppy seas that are dangerouous to small craft (U.S. Dept. Commerce, 1964).

Problems associated with sea ice can be expected at least as far south as Drift River during extremely cold years (U.S. Dept. Interior, 1976). Tuxedni Channel is reported to be blocked with ice from December to March (U.S. Dept. Commerce, 1964).

Dominant offshore surface currents are from the north. These currents and the sediment influx from the Tuxedni River contribute to a high local turbidity which results in low levels of primary and secondary productivity (Fig. 3). The northern limit of high concentrations of larval and rearing juvenile crustaceans occurs just north of Tuxedni Bay. The northern limit of shrimp distribution extends to the south headland of the bay. There are no important beds of macrophytes in Tuxedni Bay (U.S. Dept. Interior, 1976), but Chisik Island has a light cover of intertidal and subtidal macrophytes (Lees and Rosenthal, written commun.). Bivalves (Macoma and Mya) are very abundant in the intertidal mudflats of Tuxedni Bay.

Fisheries are an important economic resource of the area. Commercial fisheries for all five species of salmon occur around the entire bay and Chisik Island. Many streams in and around the bay sustain salmon runs (Alaska Dept. Fish and Game, 1975). Halibut is fished commercially off the bay mouth and around Chisik Island. Razor and hardshell clams are present in commercially harvestable quantities on the extensive tidal flats between Rusty Mountain and the Crescent River delta (Alaska Dept. Fish and Game, 1976).

Whales and dolphins occasionally occur offshore in open waters. Harbor seal densities are high near the head of the bay (Alaska Dept. Fish and Game, 1976). Tidal and contiguous freshwater wetlands around the bay are resting, feeding, nesting, and molting areas for waterfowl and seabirds. There are large seabird colonies on Chisik Island (Tuxedni National Wildlife Refuge); a few smaller colonies also occur along the shores of the bay.

The varied upland habitat supports three species of ptarmigan, grouse, two species of eagle, and ospreys. Moose are found in low densities in the bay area. Additional herbivores include muskrats, squirrels, snowshoe hares, marmots, and porcupines. Smaller furbearing predators, as well as the larger (wolverines and wolves) occur in the area. Spring intensive-use ranges of brown and black bears overlap along the north shore of Tuxedni Bay (Alaska Dept. Fish and Game, 1976). Inaccessibility and the lack of any permanent facilities have left much of the Tuxedni Bay area undeveloped. A set net fishery operates seasonally along most of the bay shore. Some trapping has taken place for smaller furbearers. The primary game animals are probably bear and waterfowl. Sport harvest of razor clams takes place along the north shore near the mouth of the bay (Alaska Dept. Fish and Game, 1976).

Drift River

Drift River lies on the west side of Cook Inlet in Redoubt Bay. Extensive tidal flats extend offshore to a mile or more. The Drift River oil terminal is located south of the river. The offshore marine terminal accommodates deep-draught vessels loading crude oil from the oil fields on the west side of Cook Inlet--Trading Bay, McArthur River, and Granite Point. Oil from offshore wells comes ashore to the north and south of Trading Bay. After formation water and gas are separated at the production treatment facilities at Trading Bay, the oil flows to the terminal (Fig. C-14) through a 20" pipeline. The terminal handled 91 arrivals in the first 6 months of 1972 and handles an estimated 9,000,000 tons of crude oil per year (U.S. Army Corps Engineers, 1974). An air flotation ballast treatment plant at the terminal receives and treats tanker ballast.

Expansion of the terminal and storage facilities at Drift River in the event of oil production in upper tracts of the lower Cook Inlet OCS lease area is being contemplated. A landing strip is located near the oil storage and transfer facility. Access is limited, because the system of roads in the area is local and does not link with other communities. However, the flat terrain and numerous sloughs and lakes permit the landing of light planes over much of the area. There are no communities in the vicinity of the facility; the nearest, Tyonek, is treated in the Trading Bay narrative.

Drift River and vicinity is in a zone of high seismic risk with potential for severe ground shaking, local and regional uplift or subsidence, alterations to surface and groundwater hydrology, tsunamis, slope failure, and other phenomena (U.S. Army Corps Engineers, 1974a).

The Drift River area is vulnerable to several hazards associated with volcanic activity. Mudflows and floods, generated by melting ice and snow on the slopes of Mount Redoubt have inundated extensive areas of the Drift River valley (U.S. Army Corps Engineers, 1974a). In addition, the Drift River area is within range of earthquakes, heavy ash falls, acid rains, and explosive blasts which could result from eruption of Mount Redoubt. This volcano is classfied as active and potentially eruptive (U.S. Army Corps Engineers, 1972).

Tsunamis resulting from landslides and seafloor displacement associated with volcanic and seismic activity in Cook Inlet could cause coastal flooding in the Drift River area. Tsunamis originating from outside Cook Inlet could also affect the Drift River area, but according to the Department of the Interior (1976), the elongate geometry of the inlet reduces the chance of such an occurrence. Glacier outburst flooding is possible along Drift River, and both the north and south forks of Big River (Post and Mays, 1971).

A combination of tides and winds can create a confused sea of high intensity, particularly in lower Cook Inlet. Maximum winds in the region can be severe, exceeding 75-100 knots over open water (U.S. Dept. Interior, 1976). In late summer and fall, strong southerly post-frontal winds result from the movement of storms west and north of the region (Federal Power Commission, 1976).

Problems associated with sea ice can be expected at Drift River during extremely cold years (U.S. Dept. Interior, 1976). During the 1970-71 season, a tanker was frozen in the ice at the Drift River terminal (U.S. Army Corps Engineers, 1974a).

Primary and secondary productivity in Redoubt Bay are undoubtedly low due to high surface suspended sediment beds during summer (Murphy et al., 1972). The extensive mudflats typically support a predominantly detrital and filter feeding community of bivalves, polychaetes, and crustaceans. Conspicuous marine macrophyte populations are reduced in the area due to less than optimal substrate and turbidity.

Muskrats, marmots, porcupines, red squirrels, snowshoe hares, arctic ground squirrels, and beaver inhabit the area. They are hunted by lynx, mink, weasels, land otters, marten, and red fox. Larger carnivores include brown and black bears, wolves, and wolverines. The range of the two species of bears overlap and both use parts of the area intensively during the spring. Brown bears continue to use the area intensively through summer and fall. Spruce grouse, golden eagles, ospreys, and bald eagles occur throughout the area. Three species of ptarmigan inhabit upland areas. Waterfowl use the salt and fresh water wetlands for nesting and molting. Commercially important fish species identified in Drift River and immediately adjacent drainages are sockeye, pink, and coho salmon. Other game fish such as Dolly Varden are likely to exist in these drainages (Alaska Dept. Fish Game, 1976).

The fish and wildlife resources of the Drift River area support moderate hunting and fishing pressure. Predominantly waterfowl, and to a lesser extent moose and bear are the primary game species. Cabins used by vacationers and hunters are on many lakes and streams in the area (King, pers. commun.).

Trading Bay

Trading Bay coastal topography is typically low relief, with extensive tidal flats characterizing much of the shoreline. The McArthur and Middle rivers and numerous smaller streams feed Trading Bay. Landing strips are located west of Granite Point and at Tyonek. A road system has developed south of Tyonek in recent years in support of proposed timber harvesting on State forest lands (Bentley, pers. commun.). There are several cabins along the coastline. Development of terminal facilities would require a pipeline extension of over a mile out from shore, similar to the Drift River operation in Redoubt Bay. Suitable acreage and bathymetric requirements for docking facilities are met at coastal areas near the west and north Forelands (Fig. C-13).

Trading Bay is the site of production treatment facilities which accept and treat upper Cook Inlet oil and transport it by pipeline to the Drift River terminal. Tyonek is the only community in the Trading Bay area. The major employers of this native village of 220 people are the fishing and forestry industries (Alaska Dept. Environmental Conservation, 1975). Domestic water is supplied by wells with a capacity of 15,000 GPD. The borough operated school had an enrollment of 98 in 1974. Housing accommodations include 68 units, many of which are mobile homes. The Village Guest House has two rooms available for travelers.

Trading Bay and vicinity lies within a zone of high seismic risk. Earthquakes could be accompanied by severe ground shaking, local and regional uplift or subsidence, alterations to surface and groundwater hydrology, tsunamis, slope failure, and other phenomena (U.S. Army Corps Engineers, 1974a).

Sea ice of fluvial origin usually covers upper Cook Inlet from late November through April (U.S. Army Corps Engineers in Federal Power Commission, 1976). Strong tidal currents keep much of the ice in nearly constant motion. At nearby Nikiski in the east shore of Cook Inlet, ice conditions pose a hazard to navigation, docking, and loading for LNG tankers. Strong southward-moving tidal currents, combined with prevailing north-northeast winds during the ice season, may aggravate ice conditions in Trading Bay. Docking facilities at Tyonek are equally stressed by ice, driven by currents often exceeding 11 knots (Wright, pers. commun.).

The Trading Bay area is vulnerable to several hazards associated with volcanic activity. Mudflows and floods generated by melting ice and snow on the slopes of Mount Spurr have inundated extensive areas along the Chakachatna River drainage. In addition, Trading Bay is within range of ash falls and acid rains that could result from eruption of either Mount Spurr or Mount Redoubt.

Mount Spurr erupted on July 9, 1953, depositing coarse lapilli near the volcano. Enough ash fell in the lowland area southeast of Beluga Lake to bend small alders. A quarter of an inch of very fine ash fell on Anchorage, disrupting air traffic for two days and necessitating costly cleanup. The initial violent outburst was accompanied by torrential rains in the immediate vicinity of the volcano. The heavy precipitation and rapid melting of ice and snow adjacent to the vent caused flash floods on tributary streams running into the Chakachatna River. Large boulders and blocks of ice as much as 10 feet in diameter were carried into the valley. Debris accompanying the flood blocked the Chakachatna River forming a lake several miles long (Juhle and Coulter, 1953).

Coastal flooding resulting from tsunamis in the Trading Bay area is possible, however, the risk of tsunamis in Cook Inlet is reported to be minimal (U.S. Army Corps Engineers, 1974a). Preliminary computer modeling experiments indicate that only very large waves with amplitudes and periods greater than those generated by the 1883 eruption of Mt. Augustine could affect the upper reaches of the inlet (U.S. Army Corps Engineers, 1972). Flooding resulting from glacier outburst floods is also possible along the Chakachatna, McArthur, and Beluga rivers (Post and Mayo, 1971). The shore of Trading Bay from West Foreland to 15 miles northward is fronted by a flat which extends 2.1 miles at the mouth of McArthur River. This shore is subject to inundation (U.S. Dept. Commerce, 1964).

Trading Bay is hazardous to navigation during part of the year. It is located in an area where high winds (75-100 knots over open water) (U.S. Dept. Interior, 1976) and extreme tidal velocities (Federal Power Commission, 1976) combine to create a confused sea state of high intensity.

Primary and secondary production are low in the turbid waters of the Trading Bay area as is the case for much of upper Cook Inlet. The surface suspended sediment load is very high during summer, typically greater than 100mg/liter (Wright et al., 1975) which acts to significantly reduce the depth of the photosynthetic zone. The broad intertidal mudflats typically support polychaetes, detritis-feeding bivalves and modest crustacean populations. Marine macrophyte populations are low to nonexistent.

Trading Bay has an undetermined area of tidal and fresh water wetlands of considerable extent that are used extensively by waterfowl. Much of the bay area is a State refuge because of its importance as waterfowl habitat (Alaska Dept. Fish and Game, 1976). Harbor seals and whales, nesting and molting waterfowl and seabirds, brown and black bear, moose and numerous small furbearing terrestrial mammals are common in Trading Bay. All five species of salmon are found in the McArthur River system. The Alaska Department of Fish and Game (1976) has documented spawning populations of coho salmon there. Known spawning areas for pink salmon are found between Tyonek and Granite Point. The Middle River supports a modest coho population. A major set net fishery for salmon has developed in Trading Bay. There are also herring and halibut in northern Trading Bay. Tidal flats and wetlands of McArthur Flats receive moderate use for waterfowl hunting (Alaska Dept. Fish and Game, 1976).

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